Document No. P-D495-004

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SDMS DocID 549657

Project Operation and Investigation Plan

Prepared for:

UniFirst Corporation
Woburn, Massachusetts

September 8, 1987

ERT®
A RESOURCE ENGINEERING COMPANY

Document No. P-D495-004

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1. INTRODUCTION

The investigative tasks described below are set forth to satisfy the technical requirements of the Order. The tasks are based on the findings derived to date from the continuing investigation and discussions among UniFirst's technical consultants and EPA. The tasks have been designed to fulfill the objectives in paragraph 18 of the Order; "investigate the nature and extent of free product in the aquifer underlying the UniFirst Property to the extent feasible."

Section 2 of this Project Operation and Investigation Plan (POIP) describes the investigative tasks to be undertaken and the schedule for execution of the work. Section 3 details the health and safety procedures to be followed during execution of the field work. Section 4 contains the quality assurance plan for the field and analytical tasks.

2. SCOPE OF INVESTIGATIVE TASKS

The nature and extent of free product in the bedrock underlying the UniFirst property (Site) will be investigated by means of installing six shallow bedrock wells and analyzing ground-water samples from these wells. Figure 2-1 illustrates the approximate locations of these proposed wells. In addition, well UC8 will be reconstructed and any remaining free product therein will be removed.

2.1 Shallow Bedrock Wells

The proposed well locations were chosen to provide direct information on whether free product is present in the shallow bedrock adjacent to well UC8 (location C and D); between wells UC8 and UC7 (location E); between wells UC8 and UC10 (locations A and B) and in the vicinity of well UC6 (location F). In addition, these wells will be constructed to provide ground-water samples and future hydraulic-testing data.

The proposed wells will be six inches in diameter. Steel casing will be installed through the unconsolidated deposits and socketed into the top of rock to the minimum depth necessary to minimize caving of the open bedrock boring. The casing will <u>not</u> be grouted in place. Boring will continue until a relatively transmissive zone is encountered or to a depth of twenty feet below the top of rock, which ever is shallowest. The wells will be finished by cutting the casing

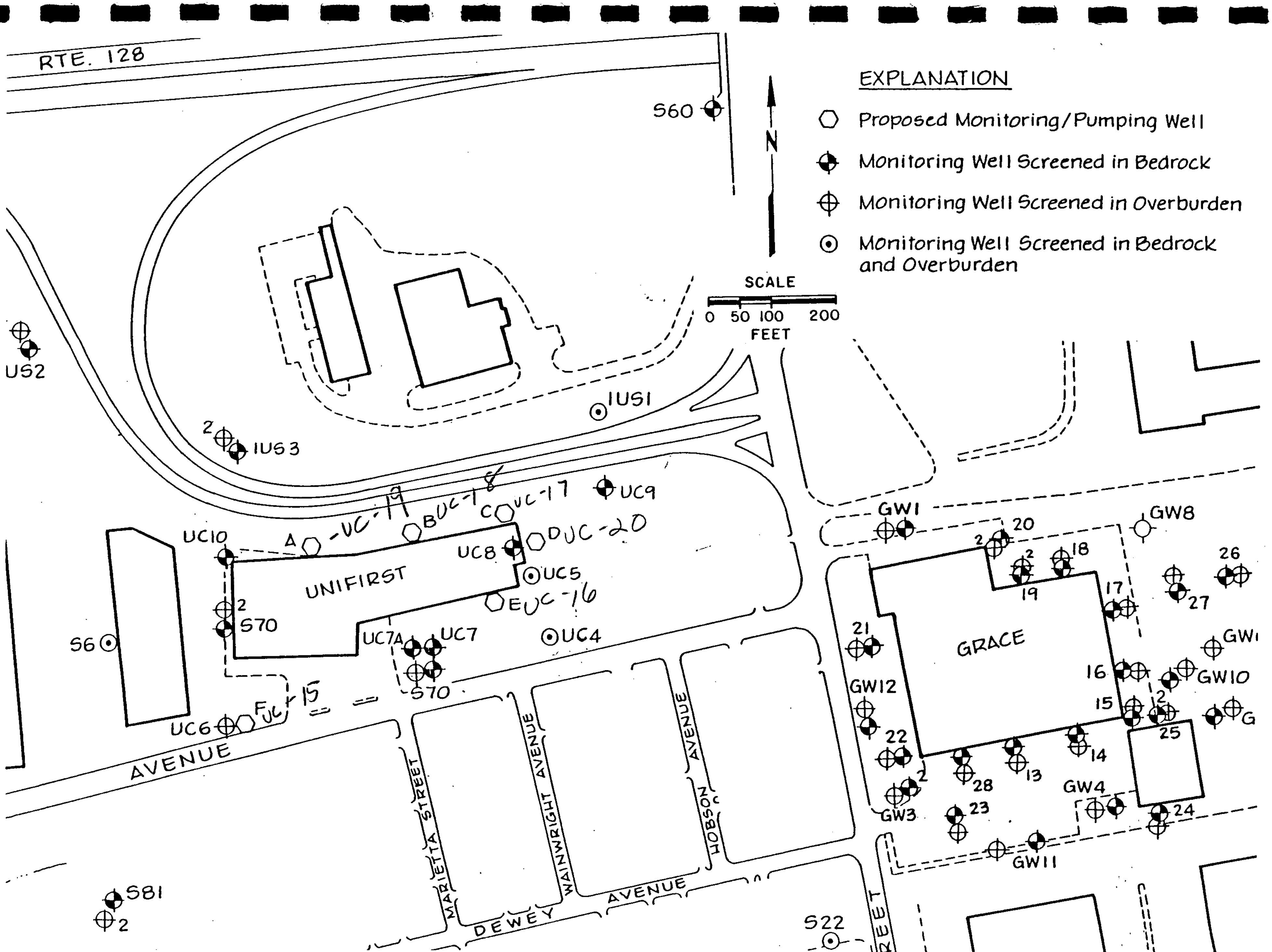

Figure 2-1 Location Map of Proposed On-Site Monitoring/Pumping Wells

off at ground surface and installing a road box supported in a concrete collar around the casing. The wells will <u>not</u> be developed or otherwise pumped until adequate time (approximately one week) has passed to allow any free product that may be present to migrate into the wells.

D.L. Maher Company (Maher) of North Reading, Massachusetts has been contracted with to drill these wells. Maher will drill the wells with an air-rotary rig that is equipped with a cuttings-collection system. This system collects the cuttings as they emerge from the annular space between the casing and the drill rods. From there, the cuttings are conducted to a cyclone from the bottom of which the cuttings are discharged in a controlled manner to a box mounted on a forklift. When the box has been filled to capacity, it will be transported to and its contents dumped into a roll-off container located on site. The level of volatile organic compounds, if any, emanating from the cuttings will be monitored with an HNu at the cyclone. Any cuttings that produce a response on the HNu greater than 10 parts per million above background levels will be placed in a separate roll-off container. These cuttings will be analyzed for volatile organic compound content upon completion of the well-installation program, and disposed of appropriately based on the results of the analysis. Franklin Pumping Service, Inc. (Franklin) of Wrentham, Massachusetts has been contracted with to provide handling, transport and appropriate disposal services for the cuttings.

Attempts to detect the presence of free product will be carried out by first lowering an electric sounder to the bottom of the boring and determining whether the circuit is broken below the water table; secondly by lowering a Teflon or stainless steel bailer to the bottom of the boring and examining the retrieved contents for free product; and finally by performing an EPA method 624 analysis on a sample of ground water. In addition, an informal HNu headspace analysis will be performed in the field on a sample of ground water from each well in order to gain a qualitative indication of the concentration, if any, of dissolved volatile compounds.

If free product is encountered in any of the new wells, it will be removed by appropriate means such as pumping or bailing. The means of removal will be determined by the amount of product present and the rate at which it flows into the well. Product removal will continue until the selected method of removal is no longer capable of cost-effectively removing separate dense non-aqueous phase liquid. All recovered product will be measured to determine the volume of product removed, and stored in DOT approved and appropriately labeled drums. The volume of the product removed will be determined by measuring the depth of product accumulated in the drum, and calculating the volume of the drum occupied by the product. The product will be sampled and analyzed for all EPA Hazardous Substance List organic compounds by the methods cited in Section 3 and for other parameters that may be required by transporters and disposers. The drummed product will be manifested, transported by Franklin directly or via a transfer station to an appropriately licensed incinerator such as the Rollins Environmental Services facility in Bridgeport, New Jersey.

2.2 Product Recovery From Well UC8

Well UC8, which is currently partially caved in, will be reconstructed by advancing a roller bit through the obstruction without using water. After drilling through the obstruction, the well will be probed as described above for free product. Any free product encountered will be removed and handled as described above. The final configuration of the reconstructed well UC8 will depend upon the rate at which product and ground water flow into the well. For example, if product continues to flow into the well after repeated bailings, it may be appropriate to ream the well out to a larger diameter such that it could receive a submersible pump and switching gear capable of automatically pumping product as it accumulates.

In addition, a sample of free product, if encountered, will be analyzed for all Hazardous Substance List organic compounds by the methods cited in Section 3.

2.3 Reporting

Pursuant to paragraph 15 of the Order, UniFirst shall submit to EPA a report that details in text supported by illustrations and tables the method of investigation, results of the field and analytical work and proposes, if necessry, additional investigative and/or removal activities. UniFirst shall append to this report all appropriate field documentation, analytical data and QA/QC documentation.

2.4 Schedule

UniFirst will commence executing the approved POIP within three working days of the execution of the consent order and receiving written approval of this plan from EPA. Figure 2-2 illustrates the estimated schedule for completion of the proposed work following receipt of approval. The schedule is indicated in weeks from the date of receipt of approval.

Although time requirements for several of the individual tasks can be estimated accurately or are limited to a period of execution by the order, most of the task schedules depend upon several variables, including: (1) EPA review and approval of the POIP; (2) completion of preceding tasks; (3) availability and performance of subcontractors; and (4) weather conditions. The estimated schedule does not take into account delays due to weather nor excessive delays due to unforeseen field conditions. Otherwise, the estimated schedule includes reasonable allowances for the variables identified above.

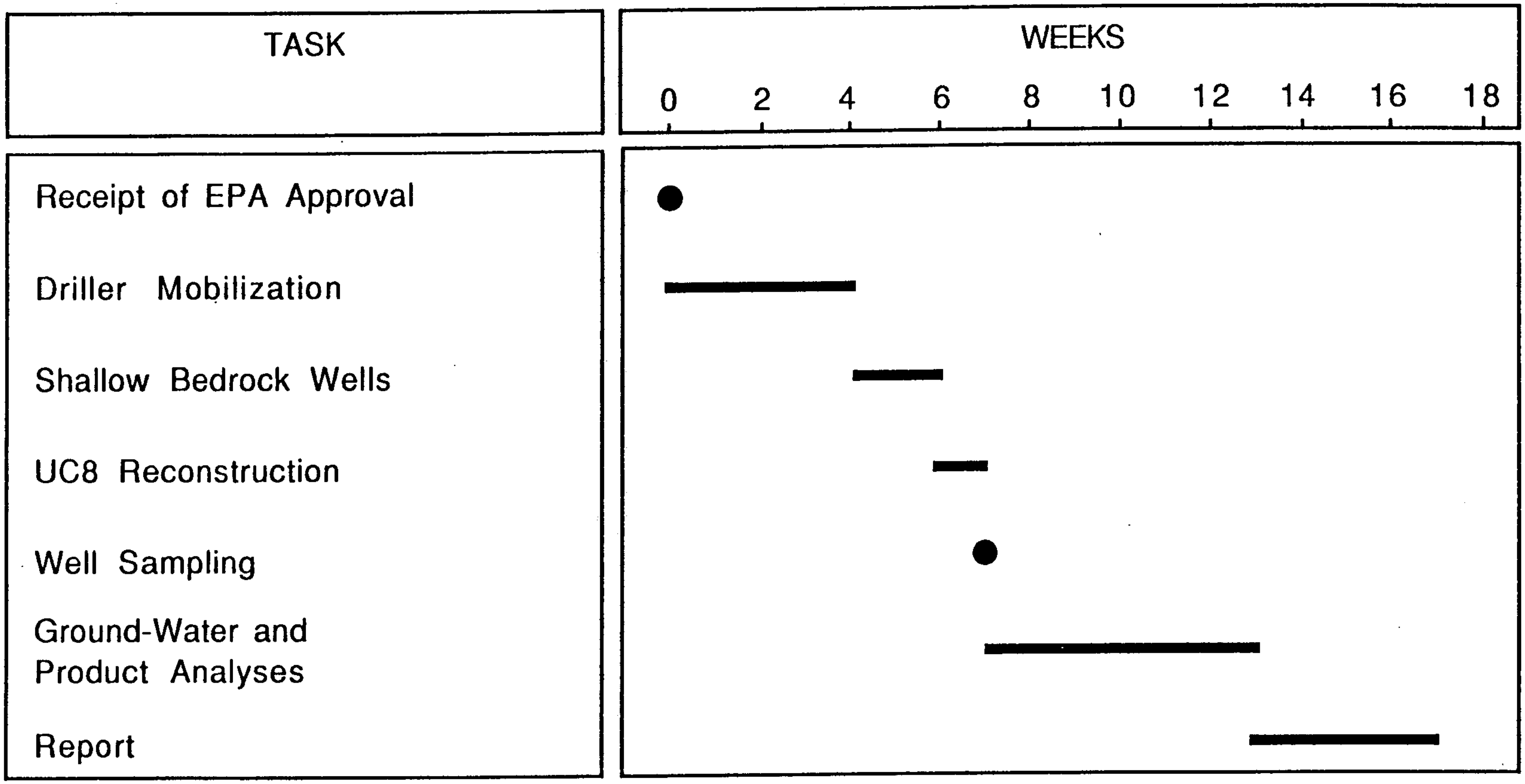

Figure 2-2 Schedule

SECTION 3

HEALTH AND SAFETY PLAN

SAFETY PLAN

for the

UniFirst Corporation
(Name of Site/Facility)

Located in

15 Olympia Rd.

Woburn, Ma
(City) (State)

Project Number: D495-004

Division Number:

Date: 8/18/87

Prepared By: Kathleen Harvey

Date: August 18, 1987

Approved By: [signature]
Project Manager

Date: 8/19/87

[signature]
Health & Safety Manager

Date: 8/19/87

SITE/PROJECT DESCRIPTION

SITE DESCRIPTION: ACTIVE? YES X NO

The facility is currently used for corporate offices and the warehousing of new uniforms.

SCOPE OF PROJECT/TASK: To investigate the nature and extent of free product in the bedrock underlying the UniFirst property to the extent feasible

PROPOSED ON-SITE ACTIVITIES: Installation of six shallow bedrock wells. Collection of the contents of these wells for subsequent laboratory anslysis. If necessary, free product in the new wells will be removed and stored appropriately. Reconstruction of well UC8 and removal of any free product.

PROPOSED DATE(S) OF FIELD ACTIVITY: September 1987

PERSONNEL REQUIREMENTS:

NAME	RESPONSIBILITY
Jeffrey T. Lawson	project manager
Lawrence Hogan	field personnel
Sharron Gaudet	field personnel

HAZARD EVALUATION

MATERIALS OF CONCERN: tetrachloroethene, trichloroethene, 1,1 dichloroethene, 1,2 dichloroethene, 1,1,1 trichloroethane, 1,1 dichloroethane, carbon tetrachloride, toluene

PHYSICAL STATE: free product may be present in the wells, otherwise materials are dissolved in ground water

HEALTH HAZARD INFORMATION: Of greatest concern is the presence of carbon tetrachloride, which can cause liver and kidney damage upon acute, high level and chronic low level exposure. Carbon tetrachloride can be directly absorbed through the skin. ACGIH classifies carbon tetrachloride as a substance suspected of carcinogenic potential. Carbon tetrachloride is a central nervous system depressant as are all of the above mentioned chemicals. Headache, fatigue and nausea as well as symptoms similar to alcohol intoxication are common symptoms of overexposure to the vapors of the above listed solvents. In addition to these effects, overexposure to carbon tetrachloride vapor may result in anorexia, flatulence, jaundice and stomach cramping. Trichloroethene, tetrachloroethene and 1,1 dichloroethene may also cause liver and kidney damage when exposures are excessive and prolonged. The presence of free product in the well(s) may pose a potential inhalation hazard. Careful and consistent air monitoring in the breathing zone is required to determine when and what type of respiratory protection is needed. Most solvents are irritating to the skin and repeated, prolonged skin contact will cause defatting, cracking and redness. If free product is found in the wells, skin contact with the liquid must be avoided. Previous data indicate that tetrachloroethene is present in higher concentrations than the other solvents. Tetrachloroethene has been demonstrated to cause cancer in laboratory animals when administered at high doses over a lifetime and the EPA classifies tetrachloroethene as a possible human carcinogen, although this classification is the subject of debate in the scientific community. The possibility of adverse exposure to the compounds of concern can be substantially reduced by following the procedures in the Health and Safety Plan.

CHEMICAL/PHYSICAL PROPERTIES: Some compounds of concern are flammable (See attached table for flash points, TLV's, vapor pressures and odor threshold)

TOPOGRAPHICAL HAZARDS: None

OPERATIONAL HAZARDS: Use of drilling rigs will require that standard precautions be taken. Hard hats will be worn whenever personnel are in the vicinity of the operating drill rig. The use of personal protective equipment during the summer months, may cause heat stress. Breaks should be taken as often as needed. Cold drinking water should be available for all personnel.

TABLE 3-1

SUMMARY OF PERTINENT PROPERTIES OF THE COMPOUNDS OF CONCERN

Chemical	Vapor Pressure (MM/Hg) @ 20°C	Flashpoint (°F)	TLV (ppm)	Odor threshold (ppm)
carbon tetrachloride	91	none reported	5	100
tetrachloroethene	14	none reported	50	5-30
trichloroethene	58	none reported	50	20-30
1,1,1 trichloroethane	100	none reported	350	100
toluene	22	40	100	5
1,1 dichloroethene	182	17	200	none reported
1,2 dichloroethene	180-265	36	200	20

PERSONAL PROTECTION/TRAINING REQUIREMENTS

RESPIRATORY PROTECTION REQUIREMENT: LEVEL C

SPECIFICATIONS: MSA ultra-twin full face respirators with GMC-H cartridges. All compounds of concern are removed by organic vapor cartridges.

MODIFICATIONS: Don respiratory protection if draeger CCl_4 detector tube readings exceed 5 ppm or if HNu detects sustained VOC levels above 40 units (based on TLV of tetrachloroethene and the response of an HNu to tetrachloroethene) or if odors become objectionable. Should levels of CCl_4 exceed 250 ppm, respiratory protection will be upgraded. If the HNu indicates sustained total VOC levels above 500 units, respiratory protection will be upgraded. Should such a situation occur, the health and safety staff at ERT-Concord, will be notified immediately.

PROTECTIVE CLOTHING REQUIREMENT: These items shall be worn should free product be encountered. Safety staff at ERT-Concord, will be notified immediately.

___	WORK CLOTHES/COVERALLS (long sleeved)	
X	CHEMICAL PROTECTIVE CLOTHING. TYPE? -	polyethylene coated Tyvek during drilling operations, well bailing and procedures, free product removal.
___	WORK SHOES (STEEL TOE/SHANK)	
X	BOOTS. TYPE?	chemically resistant/steel toe
X	GLOVES. TYPE?	nitrile with pvc inner liners
X	HARD HAT	while in the vicinity of an operating drill rig
___	FACE SHIELD	
X	SAFETY GLASSES/GOGGLES	during drilling and well bailing and free product removal if splash hazard exists.

MODIFICATIONS: uncoated Tyvek can be worn by personnel only observing the work and not in direct contact with free product.

TRAINING REQUIREMENTS: respirator fit test for all personnel going on-site. Familiarity with all monitoring equipment. All personnel should be familiar with the health and safety plan before going on-site. All ERT personnel have received the required OSHA health and safety training course.

AIR MONITORING REQUIREMENTS

1) INSTRUMENT: HNu PID-101 10.2 ev probe

2) INSTRUMENT: Draeger detector tube kit with CCl_4 5/c tubes

MONITORING PROCEDURE: The HNu will not detect the presence of CCl_4. Monitor drilling areas with both CCl_4 draeger tubes and the HNu. Monitor the breathing zone of personnel during well bailing and product removal with both air monitoring instruments. Respiratory protection will be donned if the specified action levels are indicated.

DECONTAMINATION PROCEDURES

EQUIPMENT/SOLVENTS/SOLUTIONS: Alconox detergent or equivalent

DECONTAMINATION PROCEDURES(S):

1) ITEM(S): Boots, gloves, hard hat, goggles

PROCEDURE: remove gross contamination by washing in warm soapy water. Rinse in clean water. Dry and store appropriately.

2) ITEM(S): Respirator

PROCEDURE: Thoroughly wash in clean, warm, soapy water. Rinse well. Air dry. Store appropriately.

DISPOSAL PROCEDURE: Tyvek coveralls, gloves and respirator cartridges - place in provided dumpster

NOTE: The above specified decontamination procedures pertain to the decontamination of personal protective equipment only. Procedures for the decontamination of sampling tools and other related equipment are specified in Section 3.

EMERGENCY REFERENCE

AMBULANCE: 911

POLICE: 933-1212

FIRE: 933-3131

HOSPITAL: 273-8100

Location: Lahey Clinic
41 Mall Rd.
Burlington, MA

DIRECTIONS TO HOSPITAL: MAP INCLUDED? YES

Proceed south on Route 128 (I95) to Exit 41. Proceed straight through intersection at end of ramp onto Burlington Mall Road. Lahey Clinic is on the left approximately 1/2 mile from the end of the ramp.

POISON CONTROL CENTER: 232-2120

NATIONAL RESPONSE CENTER: 1(800) 424-8802

- ERT REPRESENTATIVES:

ERT/CONCORD, MA	(617) 369-8910	
-KEVIN POWERS (HSM)	X 4349	
	(617) 773-0484	(Home)
-KATHY HARVEY	X 4234	
	(617) 665-6797	(Home)
-JEFFREY T. LAWSON (PM)	X 303	
	(617) 839-9227	(Home)

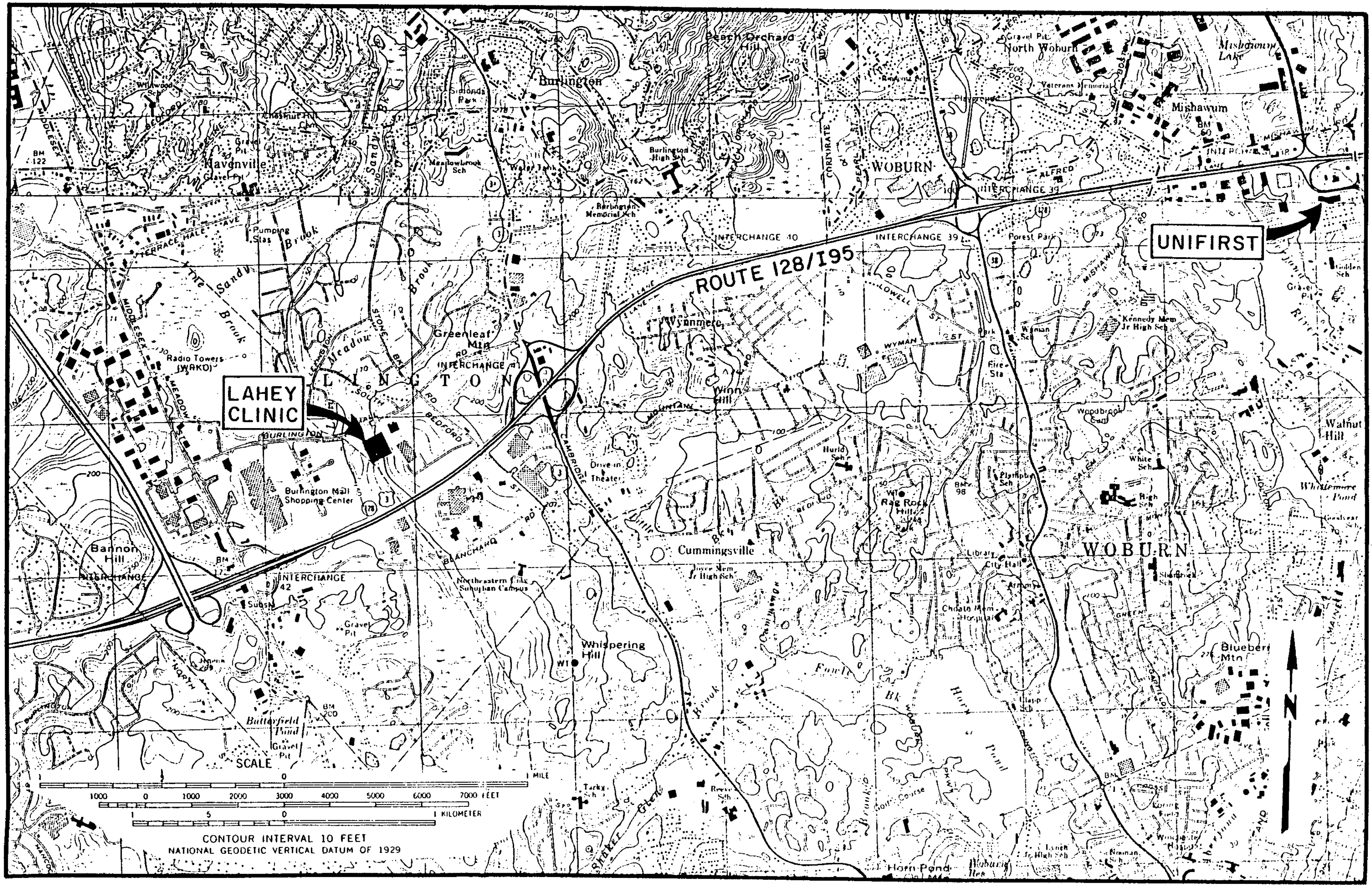

Figure 3-1 Map of Location of Nearest Hospital

- AGENCY REPRESENTATIVE: Barbara Newman (617) 565-3306

- CLIENT REPRESENTATIVE: Brian Keegan (617) 933-5800

NEAREST PHONE: In lobby of building

SECTION 4

QUALITY ASSURANCE PLAN

4. QUALITY ASSURANCE PLAN

4.1 Project Description

4.1.1 Background

Unifirst Corporation has contracted with ERT, A Resource Engineering Company (ERT) to carry out an investigation at Unifirst's site in Woburn, Massachusetts. The investigation will include installation of wells and collection and analysis of ground water and product, if present.

This plan describes the Quality Assurance (QA) organization, procedures, documentation requirements, acceptance criteria, and audit and corrective action procedures for the investigative tasks described in Section 2.

4.1.2 Project Objectives

The purpose of the project is to investigate the nature and extent of free product in the aquifer underlying the Unifirst property to the extent feasible. This objective can be efficiently met by completing the following tasks:

- Analysis of ground-water samples collected from the proposed shallow bedrock wells;
- Removal of product, if encountered; and
- Analysis of the product.

This Quality Assurance/Quality Control (QA/QC) Plan has been prepared to document the measures that will be undertaken by ERT and its subcontractors to assure that the work performed will be of proper quality to accomplish project objectives.

4.1.3 Revision Control

This project quality assurance plan is a revision-controlled document. The purpose of revision control is to ensure that:

a) the revised document remains consistent with project objectives and quality goals, and

b) all members of the project team are notified of revisions.

Each page of this project quality assurance plan contains the following information:

- page number,
- date of issuance (or effective date of revision),
- document number ("QA" followed by project number), and
- revision number.

In addition, each issued copy of the plan is numbered, so that it can be tracked as it changes hands in the event of changes in personnel assignments.

Each quality assurance plan revision must be accepted by the project manager, all affected task managers and the Quality Assurance Department prior to issuance.

When the revisions have been approved, the revision number is incremented by one and the date is changed to reflect the effective date of the revisions.

The revised quality assurance plan is distributed to all project participants with a brief summary of the changes.

DISTRIBUTION

The following personnel must receive copies of this plan, and are responsible for its implementation as it applies to their roles in the project:

Name	Title
Jeffrey Lawson	ERT Project Manager
Robert Bentley	ERT Lab. QC Manager
Tom Trainor	ERT-Wilmington Analytical Task Manager
Scott Whittemore	ERT Quality Assurance Manager
Kevin Powers	ERT Health and Safety Manager

4.2 Project Organization and Responsibilities

Figure 4-1 shows the project organization chart indicating individual assignments. All participants in the organization are directly subject to the requirements of this QA/QC Plan.

4.2.1 Authority and Responsibilities

4.2.1.1 Project Manager

The Project Manager will have responsibility for technical, financial, and scheduling matters. Other duties, as necessary, will include:

- Subcontractor procurement
- Assignment of duties of the Project Staff and orientation of the Staff to the needs and requirements of the project
- Approval of project-specific procedures and internally prepared plans, drawings, and reports
- Serve as the "collection point" for Project Staff reporting of nonconformances and changes in project documents and activities

4.2.1.2 Quality Assurance Manager

Responsibilities of the Quality Assurance (QA) Manager include:

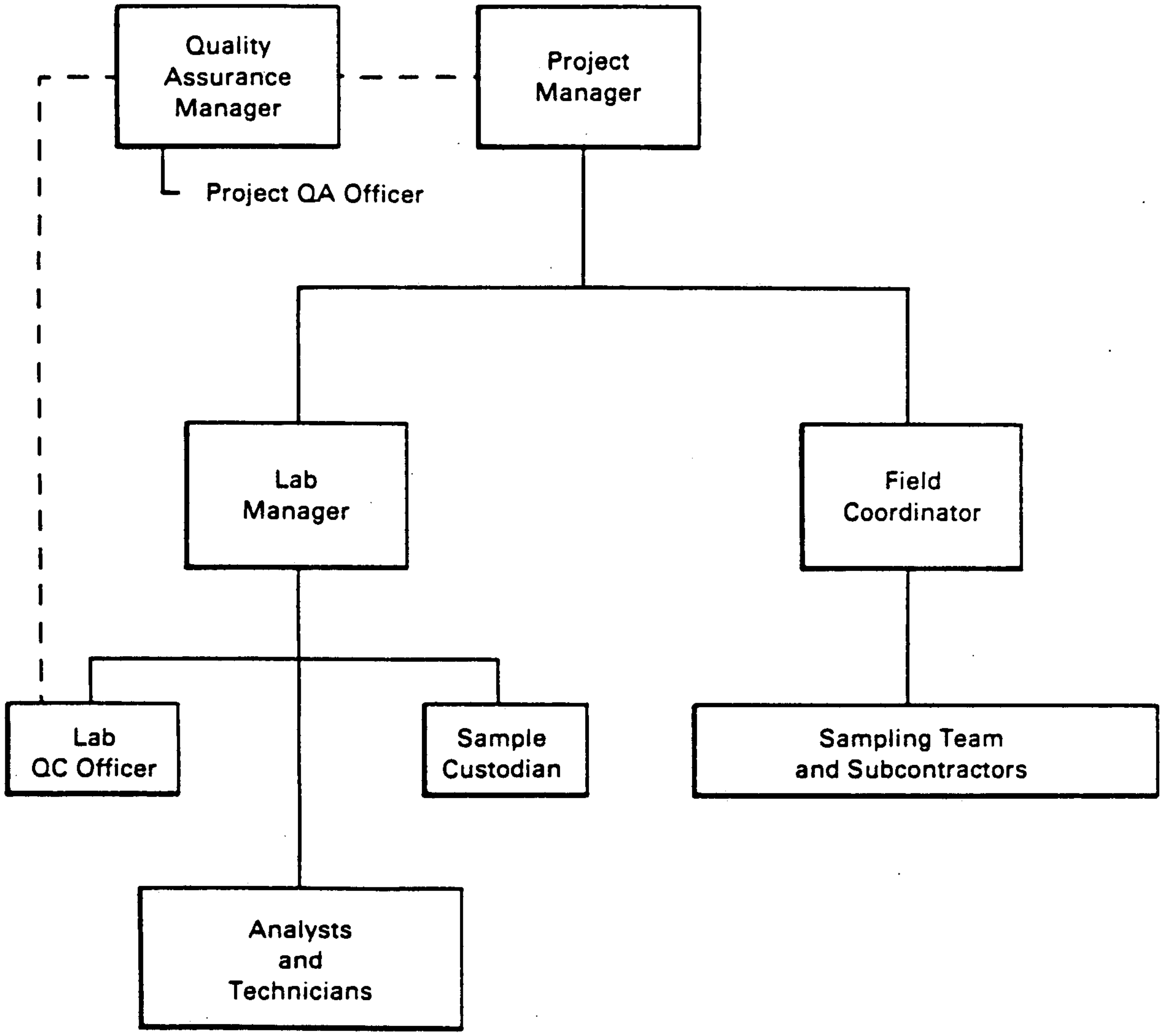

Figure 4-1 Project Organization

- Review and approval of the QA/QC plan
- Review of QA activities
- Notification to personnel of nonconformance and changes in QA procedures
- Project QA audits

4.2.1.3 Health and Safety Manager

Responsibilities of the Health and Safety (H&S) Manager include:

- Review and approval of the H&S plan
- Review of H&S activities
- Notification to personnel of nonconformances and changes in H&S procedures
- Project H&S audits.

4.2.1.4 Field Team Leader

The Field Team Leader will be responsible for field activities including those of subcontractors such as drillers. He will also be responsible for subcontractor compliance with applicable requirements of the QA/QC and H&S plans and for communication of field activity information to project management. The Field Team Leader will also be responsible for issuance and tracking of measurement and test equipment, and will be responsible for the proper labeling, handling, storage, shipping, and chain of custody procedures used at the time of sampling. The Field Team Leader will ensure that requirements of the QA/QC plan and H&S plan are adhered to by site personnel. The Field Team Leader will serve as the on-site Health and Safety Officer.

4.2.1.5 Laboratory Manager

The Laboratory Manager is responsible for overall management of laboratory operations to meet project commitments, including scheduling of personnel and physical resources.

4.2.1.6 Laboratory QC Coordinator

The Laboratory QC Coordinator is responsible for maintaining the laboratory Quality Control program. The Laboratory QC Coordinator maintains laboratory standards and traceability documentation and performs analytical data package validation. The Laboratory QC Coordinator reports directly to the Laboratory Quality Control Manager, who has indirect reporting responsibility to the Quality Assurance Manager.

4.2.2 Project Communications

Project-related materials which are incoming to ERT in the form of correspondence, sketches, logs, authorizations, or other information will be routed to the Project Manager for distribution and filing. As soon as practical, incoming correspondence originals will be placed in the project central file. If the correspondence is required by the project personnel for reference, a copy should be made rather than holding the original. Correspondence which is of importance to the QA/QC Plan will also be routed to the QA Manager.

Project-related materials transmitted external to ERT including correspondence, reports, drawings, and sketches will be appropriately reviewed, approved, and if necessary signed prior to transmittal. Project outgoing correspondence will, as a minimum, be signed by the Assistant Project Manager, or approved for distribution by the Project or Assistant Managers.

Communications relative to the project which are initiated by third parties (e.g.; media, interested individuals and groups) will be referred directly to designated Unifirst representative(s) without comment.

4.3 Quality Assurance Objectives

The purpose of the QA/QC Program is to provide internal means for control and review so that the work performed by ERT and its subcontractors is of the highest professional standards.

Project objectives are as follows:

- Data will be gathered or developed in accordance with procedures appropriate for the intended use of the data and will be of sufficient or greater quality to stand up to scientific and legal scrutiny.

- Data will be of known or acceptable precision, accuracy, representativeness, completeness, and comparability within the limits of the project.

The quality of the measurement data can be defined in terms of the following elements:

- Completeness - the adequacy in quantity of valid measurements to prevent misinterpretation and to define the nature and extent of free product.
- Representativeness - the extent to which discrete measurements accurately describe the greater picture which they are intended to represent. Good representativeness is achieved through careful, informed selection of sampling sites, drilling sites, drilling depths and analytical parameters, and through the proper collection and handling of samples to avoid interferences and prevent contamination and loss.
- Accuracy and Precision - the agreement between a measurement and the true value and the degree of variability in this agreement, respectively. Accuracy and precision of data collected in the investigation will depend upon the measurement standards used and the meticulous, competent use of them by qualified personnel.

- Comparability - the extent to which comparisons among different measurements of the same quantity or quality will yield valid conclusions. Comparability among measurements will be achieved through the use of standard procedures and standard field data sheets.
- Traceability - the extent to which data can be substantiated by hard-copy documentation. Traceability documentation exists in two essential forms: that which links quantitation to authoritative standards, and that which explicitly describes the history of each sample from collection to analysis.

The fundamental mechanisms that will be employed to achieve these quality goals can be categorized as prevention, assessment and correction, as follows:

1) Prevention of defects in the quality through planning and design, documented instructions and procedures, and careful selection and training of skilled, qualified personnel;
2) Quality assessment through a program of regular audits and inspections to supplement continual informal review;
3) Permanent correction of conditions adverse to quality through a closed-loop corrective action system.

This sampling program QA/QC Plan has been prepared in direct response to these goals. This plan describes the Quality Assurance Program to be implemented and the quality control procedures to be followed by ERT and ERT's subcontractors during the course of the site investigation that is detailed in Section 2.

4.4 Quality Assurance/Quality Control Site Exploration and Sampling

This section describes specific activities aimed at the prevention and early detection of circumstances adversely affecting quality in each of the major field tasks of the sampling program. The sampling program is summarized in Table 4-1.

4.4.1 Training

Prior to commencement of field work, the Project Manager (or designee) will provide training to the site workers and include (as appropriate):

- o Organization and lines of communication and authority,
- o Description of the site,
- o Overview of the Sampling Program and QA/QC Plan,
- o Documentation Requirements,

TABLE 4-1

SUMMARY OF SAMPLING PROGRAM

Parameters to be Analyzed	Number of Samples	Containers (Each Sample)	Number of Replicates	Number of Field Blanks	Preservation	Sample Holding Time
WATER						
VOC Screen		3 40-ml VOA	10%		Cool 4°C	14 days to analysis
VOC		3 40-ml VOA	10%	1/day	Cool 4°C	
FREE PRODUCT						
HSL Scan (Organics)		1-liter Amber Glass	10%	1/day	Cool 4°C Protect from light	7 days to extraction

- Personal Protection,
- Decontamination Procedures, and
- Emergency Procedures

4.4.2 Quality Control of Subcontractors

Periodic quality control inspections of the driller's activities will be performed by the Field Team Leader or a designee to evaluate adherence to the project Investigation Plan, QA/QC Plan and H&S Plan. Inspection will include (as appropriate):

- Type and condition of equipment,
- Calibration procedures, if required,
- Personnel qualifications, and
- Documentation

Results of the inspections will be recorded in the field notebook and reported on a regular basis to the Project Manager.

4.4.3 Field Documentation

An integral part of QA/QC of field activities will be the maintaining of a field notebook. Information obtained from field activities will be recorded and documented.

Members of the project staff working in field operations will keep a field notebook of their project activities. Items to be included in the notebook, as appropriate, are:

- Field activity subject
- Unusual events
- Visitors on site
- Subcontractor progress or problems
- ERT personnel on site
- Sample screening results
- Sampling locations
- Air monitoring measurements.

In addition, boring logs, sample logs and chain of custody forms will be prepared and kept as part of the official field record. Field records will be collected and maintained by the Field Team Leader until completion of the field program or until they are submitted to the project central file.

4.4.4 Sample Control Procedures and Chain of Custody

In addition to proper sample collection, preservation, storage and handling, it is necessary to follow proper procedures for sample identification and chain-of-custody.

4.4.4.1 Sample Identification

All samples will be containerized in appropriate bottles (Table 4-1) that have been provided by the ERT Laboratory Sample Custodian. As samples are collected and containerized, the sample containers will be labeled with the following information:

- Project Name
- Sample Number
- Station Location
- Date
- Time
- Sampler - Initials of person collecting the sample.
- Remarks - Any pertinent observations or further sample description
- Sample type and preservative (if any).

After collection, identification, and preservation, the sample is maintained under chain-of-custody procedures discussed below.

4.4.4.2 Chain-of-Custody Procedures

Chain-of-custody procedures are intended to document sample possession from the time of collection to disposal. The Field Team Leader is responsible for the care and custody of the samples collected until they are hand-delivered to the laboratory. The Field Team Leader determines whether proper custody procedures were followed during the field work and decides if additional samples are required.

TRANSFER OF CUSTODY AND SHIPMENT

1. Samples are accompanied by a chain-of-custody record (Figure 4-2) from the time they are collected until analysis is performed. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the Laboratory Sample Custodian.
2. Minimum information recorded on the chain-of-custody record in addition to the signatures and dates of all custodians will include:
   - Sampling site identification
   - Sampling date and time
   - Identification of sample collector
   - Sample identification
   - Sample description (type and quantity)
   - Analyses to be performed.
3. Each package (cooler) of samples will be accompanied by the chain-of-custody record identifying its contents. The original record will accompany the cooler, and a copy will be retained by the Field Team Leader and kept with the field notebook.

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CHAIN OF CUSTODY RECORD

Client/Project Name	Project Location	ANALYSES
Project No.	Field Logbook No.	
Sampler: (*Signature*)	Chain of Custody Tape No.	

Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample							REMARKS

Relinquished by: (*Signature*)	Date	Time	Received by: (*Signature*)	Date	Time
Relinquished by: (*Signature*)	Date	Time	Received by: (*Signature*)	Date	Time
Relinquished by: (*Signature*)	Date	Time	Received for Laboratory: (*Signature*)	Date	Time
Sample Disposal Method:			Disposed of by: (*Signature*)	Date	Time

SAMPLE COLLECTOR ERT - A Resource Engineering Company 696 Virginia Road Concord, MA 01742 617-369-8910	ANALYTICAL LABORATORY	ERT Nº 1663

1974-3-84

Figure 4-2 Chain-of-Custody Record

4. Samples will be placed in coolers after collection and hand-delivered to the ERT Analytical laboratory in Wilmington, MA. Coolers will be sealed with fiber tape to prevent accidental opening during transport.
5. The Laboratory Sample Custodian will log the samples in and indicate condition of samples as received, and will explicitly state the condition of samples and packaging/coolant. (See Section 4.5 for details of analytical laboratory QA/QC requirements).
6. The Laboratory Sample Custodian will retain a copy of each chain-of-custody record.

4.4.5 Monitoring Well Installation

Table 4-2 is a list of SOPs applicable to the project. The SOPs are contained in the appendix.

Groundwater monitoring wells will be installed in accordance with ERT SOP 7220.

The proposed wells will be four to six inches in diameter. Steel casing will be installed through the unconsolidated deposits and socketed into the top of rock to the minimum depth necessary to minimize caving of the open bedrock boring. The casing will not be grouted in place. Boring will continue until a relatively transmissive zone is encountered or a depth of twenty feet below the top of rock, which ever is shallowest. The wells will be finished by cutting the casing off at ground surface and installing a road box supported in a concrete collar around the casing. The

TABLE 4-2

STANDARD OPERATING PROCEDURE LIST

Number	Title
2005	Numerical Analysis and Peer Review
7115	Subsurface Soil Sampling
7130	Ground-water Sample Collection from Monitoring Wells
7315	Operation/Calibration of HNU Photoionization Analyzer
7510	Packaging and Shipment of Samples
7600	Decontamination of Equipment

developed or otherwise pumped until adequate time (approximately one week) has passed to allow any free product that may be present to migrate into the wells.

The Field Team Leader or other qualified individual will complete a detailed record of each boring (Form No. 1911, SOP 7115) and well installation (SOP 7220), and will log all site activities during the sampling program in the field notebook.

The Field Team Leader will be responsible for monitoring the drilling subcontractor's performance, as described in Section 4.4.2 of this plan.

4.4.6 Field Assessments

Attempts to detect the presence of free product in each well will be carried out by first lowering an electric sounder to the bottom of the boring and determining whether the circuit is broken below the water table; secondly by lowering a Teflon or stainless steel bailer to the bottom of the boring and examining the retrieved contents for free product; and finally by sending a groundwater sample from each well to ERT's Wilmington laboratory for analysis according to the procedures outlined in method 8240 of SW-846. In addition, a informal HNu headspace analysis will be performed in the field on a sample of ground water from each well in order to gain qualitative indication of the concentration, if any, of dissolved volatile compounds.

4.4.7 Sampling/Sample Preservation/Storage

4.4.7.1 Sample Containers

The ERT Analytical laboratory obtains precleaned VOA vials and 1 L amber glass containers from I-Chem Research. The supplier's cleaning regimen is as follows:

VOA Vials and Amber Glass Bottles (including caps and septa)

1. Wash with hot detergent water
2. Rinse three times with tap water
3. Rinse three times with deionized water
4. Oven dry.
5. Replace caps and septa and secure.

Containers will be stored and shipped with the Teflon-lined caps securely fastened.

4.4.7.2 Sample Collection

Ground-water samples will be collected from the monitoring wells using a Teflon or stainless steel bailer. Sample containers will not be prerinsed with sample. Sample containers will be filled to capacity, with no air bubbles. Each water sample will be containerized in two 40-ml VOA vials.

Quality Control Samples

A field blank sample will be collected by transferring laboratory deionized water to a set of sample containers via the freshly decontaminated bailer. The field sample logs will identify the blank. Field duplicate samples will be collected at the rate of 10%.

4.4.7.3 Decontamination

Drilling equipment and bailers will be decontaminated before use and between well sites, in accordance with SOP 7600, Decontamination of Equipment. Decontamination of drilling equipment will consist of thorough steam-cleaning of augers and bits. The bailer(s) will be rinsed with solvent and then deionized water and will then be air-dried.

4.4.7.4 Sample Preservation, Shipment and Storage

All samples will be shipped to the ERT Analytical Laboratory, in Wilmington, Massachusetts. Samples will be iced or refrigerated at 4°C from the time of collection until laboratory analysis. Samples will be protected from breakage and hand delivered to the laboratory in coolers containing ice or other similar cooling agents, in accordance with ERT SOP 7510. Copies of chain-of-custody records will be retained.

4.4.8 Field Measurement Equipment

Quality Control procedures for the HNU Photoionization Analyzer to be used at the Unifirst site are outlined in ERT's standard operating procedures. The air monitoring instrument will be calibrated in accordance with ERT SOP 7315 and the manufacturer's instructions. It will be the responsibility of the user to check the calibration status prior to using the instrument and to check its calibration periodically during use.

All measuring and test equipment will be calibrated prior to use and at other times when deemed necessary. Frequency will be based on the type of equipment, inherent stability, manufacturer's recommendations, values given in national standards, intended use, and experience. All field calibrations will be recorded in the field notebook.

The Field Team Leader will assume responsibility for control and calibration of field measurement equipment.

4.5 Analytical Laboratory Quality Assurance/Quality Control

4.5.1 Chemical Analysis

All analyses will be performed by the ERT Analytical Laboratory in Wilmington, MA. The ERT Analytical Laboratory operates under a formal quality control program governed by ERT's Analytical Laboratory Quality Control Handbook. This program covers quality related activities applicable to laboratory operations from the arrival of incoming samples to the issuance of validated analytical data. ERT's Wilmington Analytical Laboratory participates in the EPAs National Proficiency Sample Program and is certified by the Massachusetts DEQE for analysis of all organic and inorganic constituents in drinking (WS) and ground (WP) waters.

This section of the Quality Assurance/Quality Control Plan outlines the specific provisions of the laboratory quality control program applicable to the Unifirst sampling program. More specific detail on analytical procedures and their inherent quality control checks are to be found in the analytical method documents referenced in this section.

4.5.1.1 Log-in and Storage of Samples

All samples submitted to the laboratory for chemical analysis will be accompanied by chain-of-custody documentation. The Laboratory Sample Custodian will complete each chain-of-custody record by signing and dating it as custodian. All samples will be carefully inspected for:

- Intact air-tight seal
- Intact Chain-of-Custody seal
- Evidence of damage
- Completeness of accompanying records

No samples will be accepted by the Laboratory Sample Custodian unless they are properly labeled and sealed.

After inspection, each sample will be logged in and assigned a unique laboratory sample identification number. Information entered in the logging system for each sample will include:

- Field sample identification number
- Laboratory sample identification number
- Date received
- Project name and number
- Collection date
- Sample type
- Condition of sample (from inspection)
- Analyses sought,
- Assigned storage location.

Samples will be refrigerated in a secure location at 4°C until analyzed within the holding times specified by EPA procedures.

4.5.1.2 Analytical Quality Control

Free product samples will be screened initially for volatile and semi-volatile organic compounds by gas chromatography with a flame ionization detector (under different instrumental conditions). The purpose of the screening procedure is to provide the approximate concentration to allow for proper dilution for subsequent GC/MS analysis of all free product samples by methods 8240 and 8270. All ground-water samples will be analyzed by GC/MS for volatile organic compounds by method 8240. The following general quality control procedures will be employed in these analyses. Further details on quality control procedures are given in SW-846 methods 8240 and 8270, and the Contract Laboratory Procedures for GC/MS Analysis of Volatiles and Semi-volatiles[1].

- GC/MS Tuning - Prior to analysis of samples for the Unifirst site, the GC/MS system will be tuned by analysis of bromofluorobenzene (BFB), and must meet the ion abundance criteria before any samples or quality control samples are analyzed.
- Reagent Blanks and Method Blanks - Prior to analysis of each batch of samples from the site, the analytical method will be certified by the analysis of reagent blanks and method blanks to detect and minimize analytical interferences.
- Calibration - The GC/MS system will be calibrated with a minimum of five concentration levels of calibration standard for each parameter to be analyzed in the samples. One of the concentrations

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[1]Test methods for evaluating solid waste: Physical/Chemical Methods, SW-846, 3rd Ed. Nov. 1986; and U.S. EPA Contract Laboratory Program Statement of Work, 10/86.

of each standard will be slightly above the method detection limit. The other concentrations will correspond to the expected range of concentrations in the samples or to the linear working range of the GC/MS system. Details of the calibration procedure are provided in the analytical methods.

- Daily GC/MS Performance Tests - GC/MS performance tests will be performed in accordance with the method each day that samples from the site are to be analyzed.
- Calibration Check Standards - Each day of sample analyses for the site, after the GC/MS performance tests, calibration check standards will be analyzed to confirm the validity of the original five-point calibration. If the response to a calibration check standard differs from the initial calibration by more than $\pm$ 35%, investigation and corrective action will be performed, including a five-point recalibration, if necessary. Sample analyses will not be resumed until this criterion is met.
- Surrogate Recoveries - All samples and all standards will be spiked with surrogates (toluene - d8, bromofluorobenzene, 1,2-dichloroethane-d4) for the purpose of monitoring analytical accuracy. Surrogate recovery rates will be logged and compared to the control limits. Whenever surrogate recoveries are outside the control limits calculations will be checked for errors, degradation or contamination,

instrumental performance will be checked, and another aliquot of the extract for the affected samples(s) may be analyzed.

- Method Blanks - Method blanks will be extracted and analyzed at the rate of 1 per 15 samples analyzed. Method balnks will consist of organic-free water.
- Shipping Blanks - Each package (cooler) of sample containers sent to the site from the laboratory will contain a shipping blank consisting of two VOA vials filled with organic-free water. The blanks will remain in the cooler during sample collection and will accompany the samples back to the laboratory. The blanks will then be logged-in, stored and analyzed with the associated samples. If the blanks indicate the possibility of contamination, the Project Manager will be promptly notified.
- Duplicate Sample Analysis - 1 sample out of every 15 will be extracted and analyzed in duplicate for determination of analytical precision.
- Matrix Spikes - A matrix spike will be performed for each round of analysis or once for every 20 samples, which ever is more frequent. The procedure for matrix spikes will conform to the provisions of the Contract Laboratory Program. Reanalysis of samples will not necessarily be required when these limits are exceeded.

4.5.2 Documentation

All analytical results will be thoroughly documented in ink and in reproduction quality. Duplicate records will be kept whenever practical. Project records will be maintained in a secure area.

For each analytical result, including all blanks, spikes, calibration standards, surrogates and samples, supporting documentation will be maintained that includes at least the following:

- Complete chain-of-custody records for the sample.
- Records of traceability to Certified Reference Materials for all analytical standards, surrogate standards, spikes and balance calibration weights.
- Records of all sample preparation and analysis, including weights and volumes of sample, solvents, reagents, dilution ratios, standards, etc. These records should be in laboratory notebooks, and/or formalized data sheets, and should undergo review by a supervisor or quality control officer.
- Documentation of all manual calculations in reproduction quality.

4.5.3 Data Validation

Data validation is a process of review of the analytical results and documentation against established criteria. The

Laboratory Quality Control Officer is responsible for performing the validation.

Statistical Evaluation

The precision and accuracy of all data will be computed and compared to the control limits as part of the data validation process. Precision is determined from the analytical results of duplicate samples, or from the variance of spike or surrogate recoveries; accuracy is computed from spike recoveries.

The results of all other quality control checks will be reviewed in terms of the following criteria:

- Method blank values should be reasonably low, so that there is no evidence of contamination of reagents and glassware.
- Shipping blanks should also be reasonably low, indicating that samples have been adequately protected from contamination.
- The daily calibration curves should be linear over their entire range, and all samples analyzed should be within that range.
- Instrument performance checks, including check standards should meet method criteria.

If any of the above criteria are not met, the Laboratory Manager and Project Manager will be notified and will meet with the Laboratory Quality Control Officer to discuss remedies and the status of the data.

Documentation Review

For each batch of analyses, supporting documentation will be reviewed for completeness, correctness, and legibility in terms of the criteria in Section 4.5.2.

4.6 Numerical Analysis and Peer Review

All numerical analyses, including manual calculations, mapping, and computer modeling will be documented and subjected to quality control review in accordance with SOP 2005, Numerical Analysis and Peer Review. All records of numerical analyses will be legible, reproduction-quality and complete enough to permit logical reconstruction by a qualified individual other than the originator.

4.7 Audits and Corrective Action

Periodic audits will be conducted to assess the level of adherence to this QA plan. Routine audits of field notebooks and other controlled field documents will be conducted by the Quality Assurance Manager.

When quality deficiencies are observed that warrant immediate attention, corrective action requests will be issued to the project manager by the Quality Assurance Manager. The Corrective Action Form is shown in Figure 4-7. This is a multicopy form. The QA Officer retains one copy of the form when it is issued. The project manager completes the form and signs it when corrective action has been implemented, and returns the original to the QA Manager to close the loop.

The Quality Assurance Division maintains a record of all corrective action requests and reports their status to ERT management in a quarterly report.

ERT
A Resource Engineering Company

CAR NO. ______________

DATE ______________

CORRECTIVE ACTION REQUEST

<table>
<tr><td colspan="2">TO

FROM</td></tr>
<tr><td colspan="2">REPORTED CONDITIONS

ANSWER DUE DATE   SIGNATURE</td></tr>
<tr><td colspan="2">REVIEW AND COMMENTS

SIGNATURE</td></tr>
<tr><td>REVIEW AND COMMENTS</td><td>FOLLOW UP ACTION</td></tr>
</table>

1525-A(8/77)

Figure 4-3 Corrective Action Request

APPENDIX
STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE

Number: 2005 Date of Issue: 4th Qtr, 1985

Title: Numerical Analysis and Peer Review

Organizational Acceptance	Authorization	Date
Originator	Donald P Gay for Scott M. Whittemore	10-31-85
Department Manager	E. Moore	10 31-85
Divisional Manager	Peter Shanahan	Oct 31 1985
Group Quality Assurance Officer	Scott M. Whittemore	10-31-85
Other		

Revisions	Changes	Authorization	Date

STANDARD OPERATING PROCEDURE

Title: NUMERICAL ANALYSIS AND PEER REVIEW

Date: 4th Qtr. 1985
Number: 2005
Revision: 0

1. Purpose and Applicability

This document describes ERT's procedure for ensuring that all data analyses for site investigations and other studies are correct and consistent with project objectives and are legibly and retrievably documented. The purpose of the documentation is to permit peer review and reconstruction of the logic by which any conclusions were deduced.

2. Responsibilities

The responsibility for implementation of this procedure on each project rests with the person performing the calculations.

The project manager is responsible for ensuring the completeness of project files.

3. Method of Documentation

3.1 Manual Calculations

3.1.1 All calculations shall be documented in legible, reproduction-quality records. The records shall be complete enough to permit logical reconstruction by a qualified person other than the originator.

3.1.2 Calculations should be maintained in division files during the project, and shall be placed into the central project file at the end of the project.

3.1.3 Each calculation should be assigned a unique identification number by an appropriate person. The calculations may be consecutively numbered within a given project. (e.g., D010-1, D010-2,...).

3.1.4 Calculations for each project should be kept in a binder with an index sheet.

3.1.5 Records of calculations shall contain, on each page, the initials of the originator and reviewer, the date, the project number, calculation number and page number.

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3.1.6 Each calculation shall have a cover page which should contain:

- o client name,
- o project name and number,
- o calculation name and number,
- o total number of pages in the calculation,
- o date,
- o originator's signature.

3.1.7 The complete record of any series of calculations for a project shall have a cover page containing at least the following:

- o Statement of purpose
- o Brief description of method
- o Assumptions and justifications
- o Reference to input data sources
- o All numerical calculations, showing all units
- o Results
- o Reference to associated computer output
- o Signature of originator and date

3.2 Computer Programs

Documentation and qualification procedures for ERT-written computer programs are detailed in ERT SOP 2006. Each revision of each program is documented in an annotated hard copy of the software. Annotations should be sufficient to permit a qualified individual other than the originator to understand how the program works. Minimum contents of such a record are:

- o Program name
- o Originator's name
- o Input parameters
- o Date of printout
- o Revision number
- o Each page should be numbered, and should indicate the total number of pages in the record

These records are archived along with the qualification records in a central file.

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3.3 Computer Program Output

3.3.1 All final computer program output used in a given project will be retained in hard copy in the project files. The output should be bound and assigned a unique reference number.

3.3.2 Each program output record shall contain at least the following:

- o Name and revision date of program or model used
- o Input parameters
- o Name of user
- o Date of run

3.4 Drawings

3.4.1 All drawings shall be labeled with a unique identification number, which might consist of the project number and a sequential drawing number (e.g. D010-1, D010-2,...).

3.4.2 All drawings shall be constructed using standardized symbols and nationally-recognized drafting standards

3.4.3 All drawings shall be signed and dated by the originator and checked, signed and dated by a reviewer.

3.4.4 All drawings to be published must be approved for issue by the project manager or his designee.

4. Method for Review and Revision

4.1 All calculations and drawings for each project shall be verified by a qualified person other than the originator.

4.2 Verification shall consist of a thorough check of the calculations for the following elements:

- o Appropriateness of method,
- o Appropriateness of assumptions,
- o Correctness of calculations,
- o Completeness of references,
- o Completeness of record.
- o Correctness of input parameters for calculations using computer programs.

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4.3 Method of Review - It is the responsibility of the reviewer to assure that the methodology used and results obtained are correct. This may require verification of each number in the calculation, but this is usually not necessary. Typically, spot checks of the computations and visual inspection for the reasonableness constitute a sufficiently thorough check.

In some cases, it may be appropriate and economically feasible for the reviewer to perform a complete, independent calculation using a different, but appropriate method.

It is up to the reviewer to determine the appropriate method of review.

4.4 If the reviewer recommends revisions, the reviewer and originator will confer until any disagreements are resolved.

4.5 After determining that the calculation is acceptable, the reviewer will sign and date the cover page and initial and date the remaining pages.

4.6 A photocopy of the approved calculation record is made and filed in the central project file.

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STANDARD OPERATING PROCEDURE

Number: 7115 Date of Issue: 1st Quarter, 1984

Title: Subsurface Soil Sampling

Organizational Acceptance	Authorization	Date
Originator	Charles E. Martin	3/2/84
Department Manager	Arthur S. Lyall	3/2/84
Divisional Manager	Edgar Moore	3-2-84
Group Quality Assurance Officer	Keith W. Whittemore	3/2/84
Other		

Revisions	Changes	Authorization	Date
1	Update	SMW	3/2/84
		CEM	3/2/84
		ASL	3/2/84
		EM	3-2-84
2	4.2.3 Use of recirculated water must be documented in field notebooks and logs.	SMW	10-15-86
		EM	10-15-86
	5.0 All field documentation must be completed ASAP to ensure traceability.	CEM	10-16-86
	Miscellaneous rewording and renumbering for clarification.		

1.0 General Applicability

This SOP describes the methods used in obtaining subsurface soil samples for identification of soil grain-size distributions, stratigraphic correlations, and chemical analysis (if required). Subsurface soil samples are obtained in conjunction with soil boring and monitoring-well installation programs and provide direct information as to the physical makeup of the subsurface environment. This SOP covers subsurface soil sampling by split-spoon only, as this is the means most often used for obtaining samples from unconsolidated deposits. (See also, SOP 7220 - Monitoring Well Construction).

2.0 Responsibilities

It shall be the responsibility of the contract driller to provide the necessary materials for obtaining subsurface soil samples. This includes the split-spoon sampler and sample containers (sized according to project requirements) as well as the appropriate boring logs. It is the contract driller's responsibility to maintain a complete set of boring logs for the record. Standard Penetration Tests (SPT) (ASTM: 1586-67) will be conducted by the contract driller if required by the project. Equipment decontamination shall also be the responsibility of the driller.

It shall be the responsibility of the project geologist/engineer to observe all activities pertaining to subsurface soil sampling to ensure that all the standard procedures are followed properly, and to record all pertinent data on a boring log. It is also the geologist/engineer's responsibility to indicate to the contract driller at what specific depth samples shall be collected. The geologist/engineer will maintain custody of all samples until they are shipped or delivered to their appropriate destination.

3.0 Supporting Materials

In addition to those materials provided by the contract driller, the geologist/engineer will provide:

- sample bottles and labels
- boring logs
- field notebook
- chain-of-custody forms and tape

4.0 Methods or Protocol for Use

4.1 General Procedures

The sampling depth interval is typically one (1) sample per every five (5) vertical feet with additional samples taken, at the discretion of the project geologist/engineer, when significant textural, visual or odor changes are encountered.

The following are the standard procedures to be used in advancing casing and obtaining soil samples.

Specific requirements described in a project's task plan may call for deviations in the standard procedures but these will be taken into account on a project by project basis. Any deviations from specified procedures will be recorded on the boring log or into a field notebook.

4.2 Standard Procedures - Advancing Casing

4.2.1 The casing shall be advanced to the required depth. All loose material within the casing shall be removed prior to sampling. The casing shall be advanced according to project requirements. Borings are typically advanced by two methods, drive-and-wash casing, and hollow-stem augering. The casing shall be of the flush joint or flush couple type and of sufficient size to allow for soil sampling, coring, and/or well installation. All casing sections shall be straight and free of any obstructions. Hollow-stem augers or solid flight augers with casing may be used according to specific project requirements as described in the project task plan. If hollow-stem augers are to be used, the bit shall be equipped with a plug device to be removed at the required sampling depth.

4.2.2 For those borings which encounter obstructions, the casing shall be advanced either past or through the obstruction by drilling, mechanically fracturing, or blasting (if required). If the obstruction is bedrock, a rock core shall be taken according to project requirements and following the standard procedures for rock coring (SOP # 7210).

4.2.3 The use of recirculated water shall not be permitted when casing is being driven, unless specified in the project task plan, directed and properly documented (in field notebook, logs) by the geologist/engineer.

4.2.4 If recirculated water is used all loose material within the casing shall be removed by washing to the required sampling depth using a minimum amount of water. Care shall be taken to limit recirculation of the wash water to those times when the water supply is extremely limited or unavailable.

4.3 Standard Procedures - Soil Sampling

4.3.1 Subsurface soil samples shall be obtained using a split-tube type sampler (split spoon) having a 2-inch O.D. with a corresponding 1 3/8-inch I.D. and a 18- or 24-inch long sample capacity. It shall be equipped with a ball check valve and may require a flap valve or basket-type retainer for loose-soil sampling. Sampling frequency will be as stated in Section 4.1, or as otherwise specified in the project task plan.

4.3.2 Sampling depth shall be independently determined by the inspecting geologist, and any discrepancies shall be resolved prior to obtaining the sample.

4.3.3 Samples shall be obtained using the standard penetration test (SPT), which allows for determination of resistance within the deposits. The sampler shall be driven using a 140-pound hammer with a vertical drop of 30-inches using 1 to 2 turns of the rope on the cathead. A certificate indicating exact weight may be required for documentation purposes. The number of hammer blows required for every 6 inches of penetration shall be recorded on the boring log.

4.3.4 The sampler shall be immediately opened upon removal from the casing. If the recovery is inadequate, another attempt shall be made before drilling progresses. Adequate recovery should be no less than 12 inches, not including any residual wash material brought up with the sample.

4.3.5 The sample shall be split if necessary, placed in the appropriate container, labelled, and placed in the storage box. The boring log and the sample container/label should contain the following information for each sample: site name, boring location, depth, blow counts, recovery, sample number and collection date. The type of material shall be indicated in the boring logs and will be described using the Unified Soil Classification System (ASTM: D2487-69 and D2488-69).

4.3.6 The sampler shall be cleaned with water between attempts in order to prevent cross-contamination. If further decontamination is required, SOP 7600 shall be consulted.

4.3.7 Proper procedures for delivery to the designated laboratory shall be initiated when all samples are collected. This includes packaging, shipping with sample logs, analysis request forms, and chain of custody forms.

5.0 Documentation

Various forms are required to ensure that adequate documentation of each sample is followed and will include:

- sample logs
- boring logs
- chain of custody forms
- shipping forms

In addition, a field log book will be kept as an overall log of all samples collected throughout the study. All documents are retained in the appropriate project files idefinitely. It is important that all field documentation be as complete as possible to ensure traceability (QA/QC requirements).

Project ____________ Site ____________ BORING ________ Sh 1 of ____
Date Started ____________ Completed ____________ Ground Elevation ____________
Total Depth ____________ Location ____________ Logged by ____________
Casing I.D. ____________ Contractor ____________
Remarks ____________

Elev. Feet	Depth Feet	Sample: Type & Number	Sample: Blows per 6 In.	Sample: Depth Range	Sample: Rec.	Graphic Log	Sample Description	Equipment Installed

1911(1-81)

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ERT STANDARD OPERATING PROCEDURE

Number: 7130 Date of Issue: March 12, 1984

Title: Ground-Water Sample Collection from Monitoring Wells

Organizational Acceptance	Authorization	Date
Originator	Christopher Carlo	3-13-84
Department Manager	[illegible]	3/13/84
Divisional Manager	[illegible]	3-13-84
Group Quality Assurance Officer	[illegible]	3-13-84
Other		

Revisions	Changes	Authorization	Date
1	• Sect. 3.0 - Equipment checklists have been added.	JMW	9-5-86
	• Sect. 4.4 - The use of electronic sounding devices has been removed from procedures for obtaining water-level measurements.	CEM	9-11-86
	• Sect. 4.5 - Some unneccessary steps have been deleted from procedures for decontamination.		
	• Sect. 5.0 - The volume of ground water for purging wells has been changed from 4 to 10 volumes to 3 to 10 volumes.		
	• Sect. 6.2 - A more detailed description of bailing was added.		
	• Additional figures have been added.	Em	9-10-86
	• Miscellaneous rewording and renumbering for clarification.		

Title: Ground-Water Sample Collection from Monitoring Wells

1.0 Applicability

This Standard Operating Procedure (SOP) is concerned with the collection of valid and representative samples from ground-water monitoring wells. The scope of this document is limited to field operations and protocols applicable during ground-water sample collection.

2.0 Responsibilities

The site coordinator or his delegate will have the responsibility to oversee and ensure that all ground-water sampling is performed in accordance with the project-specific sampling program and this SOP. In addition, the site coordinator must ensure that all field workers are fully apprised of this SOP. The field team is responsible for proper sample handling as specified in SOP 7510, Handling and Storage of Samples.

3.0 Supporting Materials

The list below identifies the types of equipment which may be used for a range of ground water-sampling applications. From this list, a project-specific equipment list will be selected based upon project objectives, the depth to ground-water, purge volumes, analytical parameters and well construction. The types of sampling equipment are as follows:

- Purging/Sample Collection

  Bailers
  Centrifugal Pump
  Submersible Pump
  Peristaltic Pump

- Sample Preparation/Field Measurement

  pH Meter
  Specific Conductance Meter
  Filtration Apparatus
  Water-Level Measurement Equipment

Additional equipment to support sample collection and provide baseline worker safety will be required to some extent for each sampling task. The additional materials are separated into two primary groups: general equipment which is reusable for several samplings, and materials which are expendable.

- General

  Project-specific sampling program
  Deionized-water dispenser bottle
  Methanol-dispenser bottle
  Site-specific Health & Safety equipment (gloves, respirators, goggles)
  Field data sheets and/or log book
  Preservation solutions
  Sample containers
  Buckets and intermediate containers
  Coolers
  First-Aid kit

- Expendable Materials

  Bailer Cord
  Respirator Cartridges
  Gloves
  Water Filters
  Chemical-free paper towels
  Plastic sheets

Equipment checklists have been developed to aid in field trip organization and should be used in preparation for each trip.

4.0 Water-Level Measurement

4.1 Introduction

Prior to obtaining a water-level measurement, cut a slit in one side of the plastic sheet and slip it over and around the well, creating a clean surface onto which the sampling equipment can be positioned. This clean working area should be a minimum of eight feet square. Care will be taken not to kick, transfer, drop, or in any way let soil or other materials fall onto this sheet unless it comes from inside the well. Do not place meters, tools, equipment, etc. on the sheet unless they have been cleaned first with a clean rag.

After unlocking and/or opening a monitoring well, the first task will be to obtain a water-level measurement. Water-level measurements will be made using an electronic or mechanical device. Electronic measurement devices will be used in all wells wherein a clearly audible sound cannot be produced with a mechanical device.

4.2 Well Security

Unlock and/or open the monitoring well. Enter a description of condition of the security system and protective casing on the Ground-Water Sample Collection Record shown in Figure 1.

4.3 Measuring Point

Check for the measuring point for the well. The measuring point location should be clearly marked on the outermost casing or identified in previous sample collection records. If no measuring point can be determined, a measuring point should be established. Typically the top (highest point) of the protective or outermost well casing will be used as the measuring point. The measuring point location should be described on the Ground-Water Sample Collection Record and should be the same point used for all subsequent sampling efforts.

4.4. Measurement

To obtain a water-level measurement lower a clean steel, fiberglass tape into the monitoring well. Care must be taken to assure that the water-level measurement device hangs freely in the monitoring well and is not adhering to the wall of the well casing. The water-level measuring tape will be lowered into the well until the audible sound of the unit is detected or the light on an electronic sounder illuminates. At this time the precise measurement should be determined (to hundredth of a foot) by repeatedly raising and lowering the tape to converge on the exact measurement. The water-level measurement should be entered on the Ground-Water Sample Collection Record. As well point of measurement should be indicated; i.e., top of protective casing, top of pueriser, ground level.

4.5 Decontamination

The measurement device shall be decontaminated immediately after use with a methanol soaked towel. Generally only that portion of the tape which enters the water table should be cleaned. It is important that the measuring tape is never placed directly on the ground surface.

5.0 Purge-Volume Computation

All monitoring wells to be purged prior to sample collection. Depending upon the ease of purging, 3 to 10 volumes of ground water to be determined by hydrogeologing prior to sampling present in a well shall be withdrawn prior to sample collection or one volume if well can be purged dry. The volume of water present in each well shall be computed based on the length of water column and well casing diameter. The water volume shall be computed using Figure 2.

6.0 Well-Purging Methods

6.1 Introduction

Purging must be performed for all ground-water monitoring wells prior to sample collection in order to remove stagnant water from within the well casing and ensure that a representative sample is obtained. The following sections explain the proper procedures for purging and collecting water samples from monitoring wells.

Three general types of equipment are used for well purging: bailers, surface pumps, or down-well submersible pumps.

In all cases pH and/or specific conductance will be monitored during purging. Field parameter values will be entered on the Ground-Water Sample Collection Record along with the corresponding purge volume.

6.2 Bailing

In many cases bailing is the most convenient method for well purging. Bailers are constructed using a variety of materials; generally, PVC stainless steel, and Teflon®. Care must be taken to select a specific type of bailer that suits a study's particular needs. Teflon® bailers are generally most "inert" and are used most frequently. Keep in mind the diameter of each monitoring well so that the correct size bailers are taken to the site. It is preferable to use one bailer per well; however, field decontamination is a relatively simple task if required.

Bailing presents two potential problems with well purging. First, increased suspended solids may be present in samples as a result of the turbulence caused by raising and lowering the bailer through the water column. High solids concentrations may require that total suspended solids (TDS) and the chemical character of solids be evaluated during sample analyses. Second, bailing may not be feasible for wells which require that greater than twenty (20) gallons be removed during purging. Such bailing conditions mandate that long periods be spent during purging and sample collection or that centrifugal pumps be used. All ground-water collected from monitoring wells for subsequent volatile organic compound analyses shall be collected using bailers, regardless of the purge method.

6.3 Surface Pumping

Ground-water withdrawal using pumps located at the ground surface is commonly performed with centrifugal or peristaltic pumps.

All applications of surface pumping will be governed by the depth to the ground-water surface. Peristaltic and centrifugal pumps are limited to conditions where ground water need only be raised through approximately 20 feet of vertical distance. The lift potential of a surface pumping system will depend upon the net positive suction head of the pump and the friction losses associated with the particular suction line, as well as the relative percentage of suspended particulates.

Surface pumping can be used for many applications of well purging and ground-water sample collection. In all cases, pumping cannot be used for the collection of samples to be analyzed for volatile organic compounds (VOCs).

6.3.1 Peristaltic Pump

Peristaltic pumps provide a low rate of flow typically in the range of 0.02-0.2 gallons/min (75-750 ml/min). For this reason, peristaltic pumps are not particularly effective for well purging. Peristaltic pumps are suitable for purging situations where disturbance of the water column must be kept minimal for particularly sensitive analyses. Peristaltic pumps are most often used in conjunction with field filtering of samples and therefore can be used to obtain water samples for direct filtration at the wellhead.

6.3.2 Centrifugal Pump

Centrifugal pumps are designed to provide a high rate of pumping, in the range of 10-40 gallons per minute (gpm), depending on pump capacity. Discharge rates can also be regulated somewhat provided the pump has an adjustable throttle.

When centrifugal pumps are used, samples should be obtained from the suction (influent) line during pumping by an entrapment scheme as shown in Figure 3. Construction of this sampling scheme is relatively simple and will not be explained as part of this SOP. It is suggested that if samples cannot be obtained before going through the pump, that samples be obtained by using a bailer once pumping has ceased. Collecting samples from the pump discharge is not recommended.

6.3.3 Submersible Pump

Submersible pumps provide an effective means for well purging and in some cases sample collection. Submersible pumps are particularly useful for situations where the depth to water table is greater than twenty (20-30) feet and the depth or diameter of the well requires that a large purge volume be removed during purging.

ERT uses the Johnson-Keck pump model SP-81 which has a 1.75 inch diameter pump unit. The pump diameter restricts use to monitoring wells which have inside diameters equal to or greater than two (2) inches. As with other pump-type purge/sample collection methods, submersible pumps will not be used for the collection of samples for analyses of volatile organic compounds. Submersible pumps should never be used for well development as this <u>will</u> seriously damage the pump.

7.0 Sample Collection Procedures

7.1 Bailing

Obtain a clean/decontaminated bailer and a spool of polypropylene rope or equivalent bailer cord. Using the rope at the end of the spool tie a bowline knot or equivalent through the bailer loop. Test the knot for security and the bailer itself to ensure that all parts are intact prior to inserting the bailer into the well.

Remove the protective foil wrapping from the bailer, and lower the bailer to the bottom of the monitoring well and cut the cord at a proper length. Boiler rope should never touch the ground surface at any time during the purge routine.

Raise the bailer by grasping a section of cord using each hand alternately in a "rocking" action. This method requires that the samplers' hands be kept approximately 2-3 feet apart and that the bailer rope is alternately looped onto or off each hand as the bailer is raised and lowered.

Bailed ground water is poured from the bailer into a graduated bucket to measure the purged water volume.

For slowly recharging wells, the bailer is generally lowered to the bottom of the monitoring well and withdrawn slowly through the entire water column. Rapidly recharging wells should be purged by varying the level of bailer insertion to ensure that all stagnant water is removed. The water column should be allowed to recover to 70-90% of its static volume prior to collecting a sample. Water samples should be obtained from midpoint or lower within the water column.

Samples collected by bailing will be poured directly into sample containers from bailers which are full of fresh ground water. During sample collection, bailers will not be allowed to contact the sample containers.

7.2 Peristaltic Pump

Place a new suction and discharge line to the peristaltic pump. Silicon tubing must be used through the pump head. A second type of tubing may be attached to the silicon tubing to create the suction and discharge lines. Such connection is advantageous for the purpose of reducing tubing costs, but can only be done if airtight connections can be made. Tygon tubing will not be used when performing well purging or collecting samples for organic analysis. The suction line must be long enough to extend to the static ground-water surface and reach further should drawdown occur during pumping.

Measure the length of the suction line and lower it down the monitoring well until the end is in the upper 2-5 inches of the water column present in the well. Start the pump and direct the discharge into a graduated bucket.

Measure the pumping rate in gallons per minute by recording the time required to fill a selected volume of a bucket. Flow measurement shall be performed three times to obtain an average rate.

The pumping shall be monitored to assure continuous discharge. If drawdown causes the discharge to stop, the suction line will be lowered very slowly further down into the well until pumping restarts.

Measurements of pH and specific conductance will be made periodically during well purging. All readings will be entered on the Ground-Water Sample Collection Record.

Samples will be collected after the required purge volume has been withdrawn and the field parameters (pH and Specific Conductance) have stabilized.

When the sample bottles are prepared, each shall be filled directly from the discharge line of the peristaltic pump. Care will be taken to keep the pump discharge line from contacting the sample bottles. Ground-water samples requiring filtration prior to placement in sample containers, will be placed in intermediate containers for subsequent filtration or filtered directly using the peristatic pump.

At each monitoring point when use of the peristaltic pump is complete, all tubing including the suction line, pump head and discharge line must be disposed of. In some cases where sampling will be performed frequently at the same point, the peristaltic pump tubing may be retained between each use in a clean zip-lock plastic bag.

7.3 Centrifugal Pump

7.3.1 Direct Connection Method (Note: This method requires that the well casing be threaded at the top.)

Establish direct connection to the top of the monitoring well if possible using pipe connections, extensions, and elbows, with Teflon® tape wrapping on all threaded connections. If the centrifugal pump will subsequently be used for sample collection, a sample isolation chamber will be placed in the suction line configuration as shown in Figure 3.

Prime the pump by adding tap water to the pump housing until the housing begins to overflow.

Start the pump and direct the discharge into a graduated bucket or a bucket of known capacity (>2.5 gallons).

Start the pump and measure the pumping rate in gallons per minute by recording the time required to fill the graduated bucket. Flow measurement should be checked periodically to determine if pumping rates are continuous, fluctuating, or diminishing. If discharge stops, the pump will be throttled back to determine if pumping will restart at a lower rate. If pumping does not restart, the pump should be shut off to allow the well to recharge.

Measurements of pH and specific conductance will be made periodically during well purging. All readings will be entered on the Ground-Water Sample Collection Record. Samples will be collected after the required purge volume has been withdrawn and the field parameters (pH and Specific Conductance) have stabilized. Samples should be collected from an in-line discharge valve or with a bailer. The pump should be properly decontaminated between wells.

7.3.2 Down-Well Suction-Line Method

Lower a new suction line into the well. The suction line will have a total length great enough to extend to the water table and account for a minimum of five (5) feet of drawdown. Note should be made that drawdown may exceed the depth where pumping will terminate as a result of a limitation derived from suction-line conditions and the lift potential of the pump. All connections should be made using Teflon® ferrules and Teflon® thread wrapping tape. Run the pump as per Section 7.3.1.

At each monitoring well when use of a centrifugal pump is complete, all suction line tubing should be disposed of properly.

7.4 Submersible Pump

Prior to using a submersible pump, a check will be made of well diameter and alignment. A 1.75 inch diameter decontaminated cylindrical tube should be lowered to the bottom of each monitoring well to determine if the alignment or plumbness of a well is adequate to accommodate the submersible pump. All observations will be entered in the Ground-Water Sample Collection Record.

Slowly lower the submersible pump into the monitoring well taking notice of any roughness or restrictions within the riser.

Count the graduations on the pump discharge line and stop lowering when the stainless steel portion is below the uppermost section of the static water column within monitoring well. Secure the discharge line and power cord to the well casing.

Connect the power cord to the power source (i.e., rechargeable battery pack or auto battery monitor) and turn the pump on (forward mode). When running, the pump can usually be heard by listening near the well head.

Voltage and amperage meter readings on the pump discharge must be checked continuously. The voltage reading will decline slowly during the course of a field day representing the use of power from the battery. Amperage readings will vary depending upon the depth to water table. Amperage readings greater than 10 amps usually indicate a high solids content in the ground water which may cause pump clogging and serious damage. If a steady increase in amperage is observed, the pump should be shut off, allowed to stop, switched to the reverse mode, stopped again and then placed in forward mode. If high amperage readings persist, the pump should be withdrawn and checked using the large upright cylinder and tap water. Ground-water conditions such as high solids may require that an alternate purge/sample method be used.

Drawdown must also be monitored continuously by remaining near the well at all times and listening to the pump. When drawdown occurs, a metallic rotary sound will be heard as the pump intake becomes exposed and ceases to discharge water, but continues to run. The pump should be lowered immediately to continue pumping water within the uppermost section of the static water column. NOTE: The submersible pump cannot be allowed to run while not pumping for more than five seconds or the pump motor will burn out.

If drawdown continues to the extent that the well is pumped dry, the pump should be shut off and the well allowed to recharge. This on/off cycle may need to be repeated several times in order to purge the well properly.

Measurements of the pumping rate, pH, and specific conductance should be made periodically during well purging. All readings and respective purge volumes should be entered on the Ground-Water Sample Collection Record.

While pumping is on-going and when sample bottles are prepared, bottles will be filled directly from the discharge line of the pump taking care not to touch sample bottles to the discharge line.

At each monitoring well when use of the submersible pump is complete, the pump, discharge line and power cord shall be decontaminated according to the procedures contained in the SOP for Decontamination.

8.0 Sample Preparation

8.1 Introduction

Prior to sample transport or shipment, ground-water samples may require filtration and/or preservation dependent on the specific type of analysis required.

Specific preservation techniques are described in the EPA document, Handbook for Sampling and Sample Preservation of Water and Wastewater (EPA-600/4-82-029). The EPA manual and laboratory manager should be consulted during the planning stage of the project. Project-specific sampling plans shall be assembled using the approved procedures obtained from the EPA manual.

8.2 Filtration

Ground-water samples collected for dissolved metals analyses will be filtered prior to being placed in sample containers. Ground-water filtration will be performed using a peristaltic pump and a 0.45 micron, water filter. Typically the water filters are 142 mm in diameter and are usually placed in 142 mm polycarbonate housings.

The filtration of ground-water samples shall be performed either directly from the monitoring well or from intermediate sample containers such as decontaminated buckets. In either case, well purging shall be performed first. Fresh ground water shall then be filtered and discharged from the filtration apparatus directly into sample containers. For most dissolved metal analyses, pH adjustment of the sample is also required and shall be performed after filling the sample bottles. This is generally accomplished using laboratory supplied compounds such as sulfuric or nitric acid and sodium hydroxide.

9.0 Documentation

A number of different documents must be completed and maintained as a part of ground-water sampling effort. The documents provide a summary of the sample-collection procedures and conditions, shipment method, the analyses requested and the custody history. The list of documents is:

- Ground-water sample collection record
- Sample labels
- Chain of custody forms and tape
- Shipping receipts

Sample labels shall be completed at the time each sample is collected and will include the information listed below. A sample label is shown in Figure 4.

- Client or project name
- Sample number
- Designation (i.e., identification of sample point no.)
- Analysis
- Preservative (e.g., filtration, acidified pH<2 HNO_3)
- Sample-collection date
- Sampler's name

Figure 5 displays the chain of custody record used by ERT. The chain of custody form is the record sample collection and transfer of custody. Information such as the sample collection date and time of collection, sample identification and origination, client or project name shall be entered on each chain of custody record. In accordance with 40 CFR 261.4(d) the following information must accompany all ground water samples which are known to be non-hazardous and to which U.S. Department of Transportation and U.S. Post Office regulations do not apply. Such information is:

- sample collector's name, mailing address and telephone number,
- analytical laboratory's name, mailing address and telephone number,
- quantity of each sample,
- date of shipment, and
- description of sample.

The chain of custody forms provide a location for entry of the above-listed information.

10.0 References

EPA, Handbook for Sampling and Sample Preservation of Water and Wastewater EPA-600/4-82-029, September 1982.

Geotrans, Inc. RCRA Permit Writer's Manual, Ground-Water Protection prepared for U.S. EPA. Contract No. 68-01-6464, October 1983.

Code of Federal Regulations, Chapter 40 (Section 261.4(d).

Figure 1

ERT

Well No. ______

GROUND WATER SAMPLE COLLECTION RECORD

Job No. __________ Date: __________

Location: ______________________________ Time: S ______

Weather Conds.: ______________________________ F ______

1. WATER LEVEL DATA: (from ToC) ToC Elevation (from LS) __________
   a. Total Well Length (+ TC) __________ (known, meas.) Tape Corr. (TC) __________
   b. Water Table Elev. (+ TC) __________ Well Dia. __________
   c. Length of Water Column __________ (a-b)

2. WELL PURGING DATA:
   a. Purge Method ______________________________
   b. Required Purge Volume (@ ____ well volumes) ______________________________
   c. Field Testing: Equipment Used ______________________________

Volume Removed	T°	PH	Spec. Cond.	Color

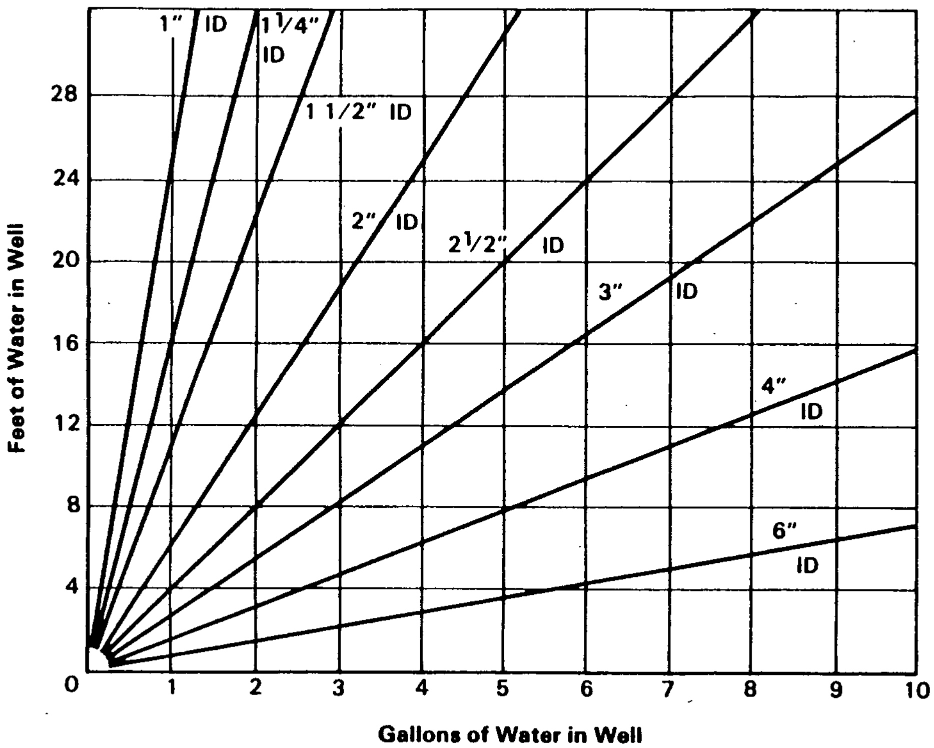
3. Sample Collection: Method ______________________________

Container Type	Preservation	Analysis Req.

Comments: ______________________________

1995/12-84

8403004



(a) Graphical Explanation

Volume/Linear Ft. of Pipe		
ID(in)	Gal	Liter
1/4	0.003	0.010
3/8	0.006	0.022
1/2	0.010	0.039
3/4	0.023	0.087
1	0.041	0.154
2	0.163	0.618
3	0.367	1.39
4	0.653	2.47
6	1.47	5.56

(b) Volume Factors

Figure 2 Purge Volume Computation

8403003

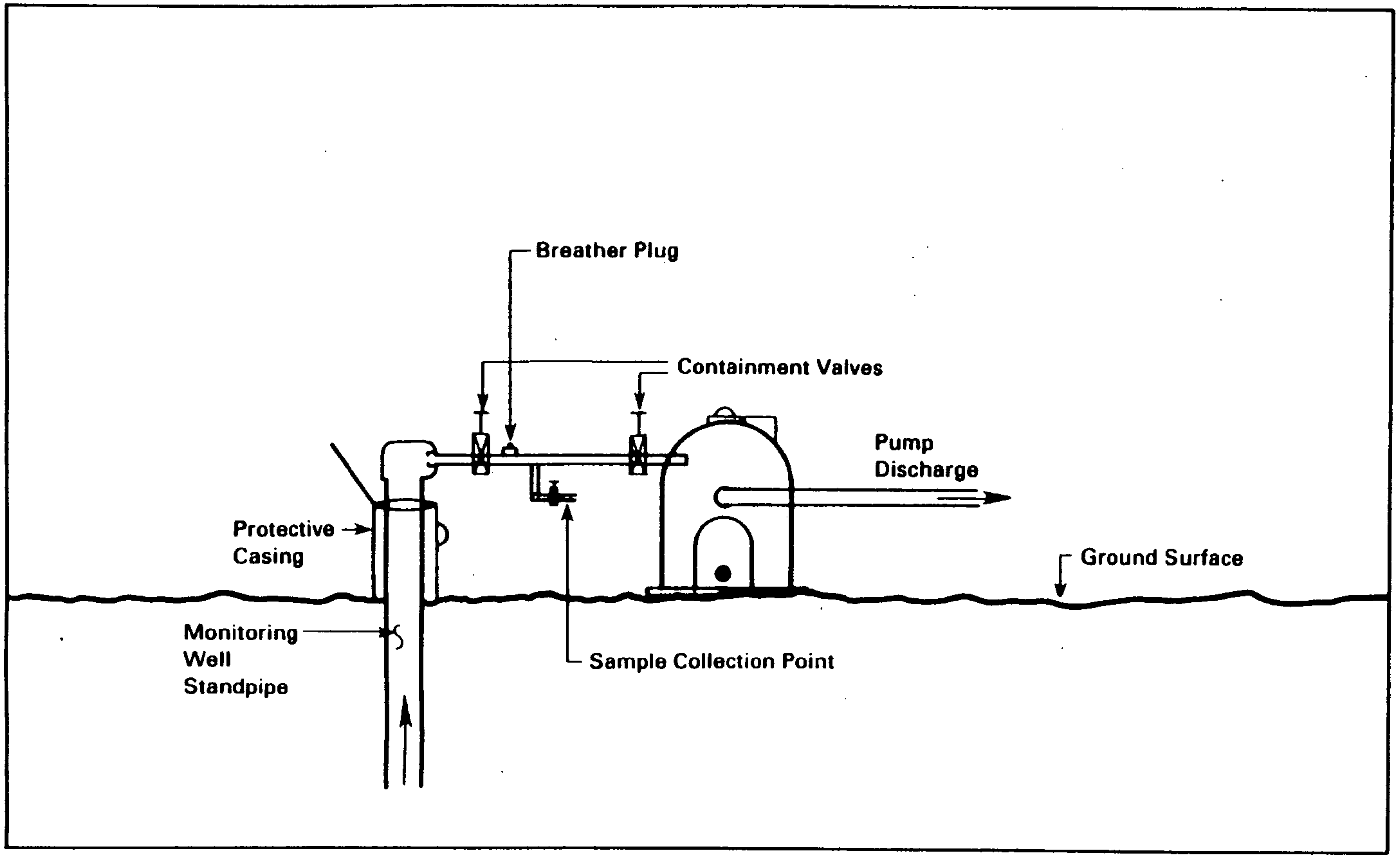


Figure 3 Down Well Suction Line Configuration

CLIENT ______________________

SAMPLE NO. ______________________

DESIGNATION ______________________

ANALYSIS ______________________

PRESERVATIVE ______________________

DATE ____________ BY ____________

Figure 4 Sample Container Label

CHAIN OF CUSTODY RECORD

Client/Project Name	Project Location	ANALYSES
Project No.	Field Logbook No.	
Sampler: (*Signature*)	Chain of Custody Tape No.	

Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample							REMARKS

Relinquished by: (*Signature*)	Date	Time	Received by: (*Signature*)	Date	Time
Relinquished by: (*Signature*)	Date	Time	Received by: (*Signature*)	Date	Time
Relinquished by: (*Signature*)	Date	Time	Received for Laboratory: (*Signature*)	Date	Time
Sample Disposal Method:			Disposed of by: (*Signature*)	Date	Time
SAMPLE COLLECTOR			ANALYTICAL LABORATORY	No.	

1974-3-84

Figure 5 Sample Chain-of-Custody Record

ERT STANDARD OPERATING PROCEDURE

Number: 7315 Date of Issue: March 12, 1984

Title: Operation/Calibration of HNu Photoionization Analyzer

Organizational Acceptance	Authorization	Date
Originator	Charles E Martin	3/13/84
Department Manager	[illegible]	3/13/84
Divisional Manager	Elaine Moore	3-13-84
Group Quality Assurance Officer	Scott M. Whittemore	3-13-84
Other		

Revisions	Changes	Authorization	Date
1	COMPLETE RE-WRITE	Scott M. Whittemore	5-1-87
		Charles E Martin	5-6-87
		Elaine Moore	5-6-87

Title: Operation/Calibration of HNU Photoionization Analyzer

1.0 Introduction

The HNU is primarily used by ERT personnel for safety and survey monitoring of ambient air, determining the presence of volatiles in soil and water, and detecting leakage of volatiles.

Personnel responsible for using the HNU should first read and thoroughly familiarize themselves with the factory operator instruction manual.

2.0 Principle of Operation

The HNU is a non-specific vapor/gas detector. The hand-held probe houses a photoionization detector (PID), consisting of an ultraviolet (UV) lamp and two electrodes, and a small fan which pulls ambient air into the probe inlet tube. All organic and inorganic vapor/gas compounds having ionization potentials (IP) lower than the energy output of the UV lamp are ionized; and the resulting potentiometric change is seen as a needle deflection, proportional to vapor concentration, on the potentiometer of the readout/control box.

3.0 Specifications

Detection range*:	0.1 to 2,000 ppm.
Linear range*:	0.1 to 400 ppm.
Response time:	3 seconds to 90% full scale deflection.
Operating temperature:	-10°C to 40°C.
Operating time on battery, continuous use, without recorder:	approximately 10 hours; at lower temperatures time is reduced.
Recharge from full discharge:	full recharge 12-14 hours.

* When equipped with 10.2 eV probe with SPAN set at 9.8 and measuring benzene. Values may vary for other compounds and conditions.

4.0 Required Materials

- Calibration Gas: Compressed gas cylinder of isobutylene in air or similar stable gas mixture of known concentration. The selected gas should have an ionization potential similar to that of the vapors to be monitored, if known. The concentration should be at 50-75% of the range in which the instrument is to be calibrated.

- Regulator for calibration gas cylinder
- Approximately 3-4 feet of teflon tubing
- "Magic Marker"

5.0 Preliminary Steps

Preliminary steps (battery charging, check-out, calibration, maintenance) should be conducted in a controlled or non-hazardous environment.

The sensor probe is carried separately in the instrument carrying case. For most safety and survey work, the 10.2 eV probe is used, as it detects more compounds than the 9.5 eV probe and is more durable than the 11.7 eV probe. Unclamp the cover from the readout/control box and remove the inner lid from the cover. Screw the inlet tube onto the sensor probe. Attach the probe cable plug to the 12 pin keyed socket on the readout panel by matching the alignment slot in the plug to the key in the connector, and screwing down the probe connector until a distinct snap and lock is felt.

Turn the function switch to the BATT (battery check) position. The meter needle will deflect to the green zone if the battery is fully charged. If the needle is below the green arc or if the low battery indicator comes on, the battery must be recharged (Section 9.0) before the analyzer is used.

Turn the function switch to the STANDBY position and allow the electronics to warm up for five minutes. Next turn the ZERO adjustment knob until the meter needle is at zero.

6.0 Operation

Turn the function switch to the appropriate range. Check to see if the intake fan is functioning; if so, the probe will vibrate slightly and a distinct sound will be audible when holding the probe casing next to the ear. Also, verify that the UV lamp is on by briefly looking into the probe from a distance greater than six inches to observe a purple glow.

WARNING: Continued exposure to ultraviolet energy generated by the light source can be harmful to eyesight.

At the beginning of each day, check the calibration (Section 7.2) and make adjustments if necessary (Section 7.3). Record the calibration information in the field log book.

The instrument is now operational. Readings should be taken on the lowest possible scale and recorded in the field log book.

When the HNU is not being used or between monitoring intervals, the function switch should be set on the STANDBY position to conserve battery power and UV lamp life.

At the end of each day, recheck calibration (Section 7.2) and record the information in the field log book.

To shutdown the HNU, turn the function switch to OFF.

Recharge the battery after each use (Section 9.0).

When transporting, disconnect the probe cable connector from the control panel and return the instrument to its stored condition.

7.0 Calibration Procedures

7.1 Start-Up

Battery Check (Section 5.0).

Zero Set (Section 5.0).

For measurement on the 0-20 or 0-200 ranges only one calibration gas standard is required. Calibration on the 0-200 range will provide accurate values on the 0-20 range as well. Connect the probe tip to the gas cylinder regulator, observing safety precautions, in order that the gas is delivered to the probe at atmospheric pressure (Figure 7-1). A t-fitting and plastic tubing can be used. Adjust the regulator so that the gas is delivered at 150-200 cubic centimeters per minute. The fan inside the probe draws approximately 100 cc/min.

7.2 Calibration Check

Set the function switch to the proper range setting, based on the calibration gas used, and record the meter reading in the field log book. Also record the calibration gas composition and concentration, the date and the time.

7.3 Calibration Adjustment

If adjustment is necessary, turn the span as required to read the ppm concentration of the gas standard, or the equivalent concentration of benzene if the HNU is being calibrated to benzene.

Recheck the zero setting (Section 5.0)

If reajustment of the zero setting is necessary, repeat the span adjustment. Record the span setting and the new meter reading. Whenever the span is changed, the zeroing procedure should be repeated.

If calibration cannot be achieved or if the span setting resulting from calibration is 0.0, then the lamp must be cleaned (Section 10.0).

7.4 Alternate Calibration Technique

It may be more convenient in certain circumstances to employ the use of a Tedler bag filled with calibrant instead of a calibration cylinder. In that case, the bag (usually 3-10 liter capacity) should be filled with the appropriate calibrant and brought to the HNU. The HNU probe should be connected to the discharge fitting on the bag using a piece of flexible tubing. Allow the HNU to draw the calibrant from the bag and follow the instructions as indicated in 7.2, 7.3.

8.0 Troubleshooting Tips

One convenient method for periodically confirming instrument response is to hold the sensor probe next to the tip of a magic marker. A significant needle deflection should be observed within 3 seconds with the function switch set at 0-20 (after shave lotion or cologne also will make the needle deflect).

Air currents or drafts in the vicinity of the probe tip may cause fluctuations in readings.

A fogged or dirty lamp (Section 10.0), due to operation in a humid or dusty environment, may cause erratic or fluctuating readings.

Moving the instrument from a cool or air-conditioned area to a warmer area may cause moisture to condense on the UV lamp and produce unstable readings (Section 10.0).

A zero reading on the meter should not necessarily be interpreted as an absence of air contaminants. The detection capabilities of the HNU are limited to those compounds which will be ionized by the particular probe used.

Many volatile compounds have a low odor threshold. A lack of meter response in the presence of odors does not necessarily indicate instrument failure.

If a negative deflection of the HNU meter is noted the ion chamber is dirty and needs cleaning. The chamber may be soaked in a solvent such as methanol in a soil bath air dried and then baked for two to four hours at a temperature of 100°C and not exceeding 105°C.

When high concentrations of hydrocarbons enter the ionization chamber in the HNU a "quenching" effect takes place. Typically, it is noted by a sharp needle movement once the flow of gas is pierced by the HNU probe. Within one to two seconds the needle fades to zero point. To check whether or not the quenching effect is taking place, move the HNU probe to just outside the hole created in the foil. Get another reading after five to ten seconds. If quenching is taking place a very eradic needle movement will occur. Once an operator has seen this phenomena it is fairly easy to recognize.

9.0 Battery Charging

The battery charger is stored inside the instrument cover. To charge the battery, first insert the mini plug of the charger into the jack on the side of the meter, with the function switch in the OFF position. Next, insert the charger plug into a 120VAC single phase, 50-60 HZ outlet. To ensure that the charger is functioning, turn the function switch to BATT. The meter should deflect full scale. The sensor probe cable must be connected to the control panel for a battery check response. For normal battery charging, leave the function switch in the OFF position. The battery is fully charged after 14 hours of charging. The charger can be left on indefinitely without damage. Disconnect the charger from the electrical outlet before disconnecting the mini plug from the instrument.

With the function switch turned to the appropriate range setting, the HNU may be operated while recharging.

10.0 Probe Cleaning

During periods of operation, moisture, dust, or other foreign matter can be drawn into the probe and form deposits on the surface of the UV lamp and ion chamber. This causes interference with the ionization process and produces erroneous readings. This condition is indicated by meter readings that are low, erratic, unstable, non-repeatable, or drifting. In most cases, the following field cleaning procedure is sufficient to correct this condition.

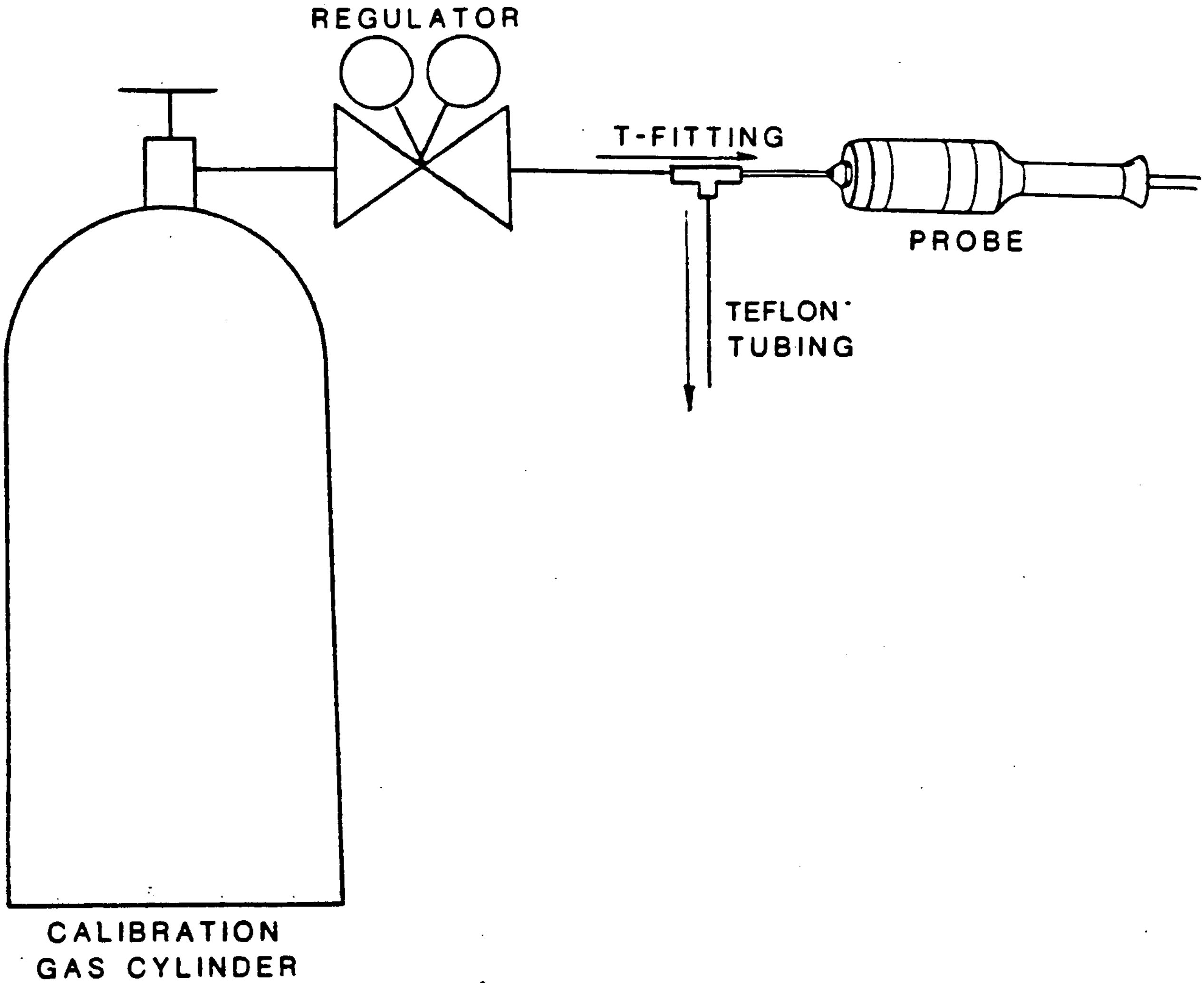
Turn the function switch to the OFF position. Disconnect the probe cable connector at the readout panel. Unscrew the probe inlet tube from the end cap and clean the inside of the tube making sure that the tube is dry and lint-free when finished. A pipe cleaner, or a kim-wipe and piece of wire, can be used. Keeping the probe upright, remove the two screws holding the end cap in place and remove the cap and ion chamber. Place one hand over the top of the lamp housing and tilt slightly. The light source will slide out of the housing. Take care not to lose or misplace o-rings or other parts. Do not touch the internal parts of the probe, particularly the UV lamp, with the bare hand during cleaning or reassembly. Surgical gloves are recommended. Clean the internal parts with a non-abrasive, lint-free paper towel (e.g., kim-wipe) and reassemble the probe.

11.0 Documentation

Safety and survey monitoring with the HNU will be documented in a bound field log book and retained in the project files. The following information is to be recorded:

- Project name and number.
- Operator's signature.
- Date and time of operation.
- Calibration gas used.
- Calibration check at beginning and end of day (meter readings before adjustment).
- Span setting after calibration adjustment.
- Meter readings (monitoring data obtained).
- Instances of erratic or questionable meter readings and corrective actions taken.
- Instrument response verifications - magic marker (Section 8.0) or similar test.

Figure 7-1


REGULATOR
T-FITTING
PROBE
TEFLON
TUBING
CALIBRATION
GAS CYLINDER

ERT STANDARD OPERATING PROCEDURE

Number: 7510 Date of Issue: March 12, 1984

Title: Packaging and Shipment of Samples

Organizational Acceptance	Authorization	Date
Originator	Christopher Carle	3-12-84
Department Manager	[illegible]	3/13/84
Divisional Manager		
Group Quality Assurance Officer		
Other		

Revisions	Changes	Authorization	Date
1	• Sect. 4.11 Chain-of-Custody procedure for hinged coolers added • Miscellaneous rewording for clarification	[illegible] M. Whittemore [illegible] Moore	9-19-86 10-13-86

1.0 Applicability

This Standard Operating Procedure (SOP) is concerned with procedures associated with the packaging and shipment of samples. Two general categories of samples exist: environmental samples consisting of air, water and soil; and waste samples which include non-hazardous solid wastes and hazardous wastes as defined by 40 CFR Part 261.

2.0 Responsibilities

It is the responsibility of the project manager to assure that the proper packaging and shipping techniques are utilized for each project. The site operations manager shall be responsible for the enactment and completion of the packaging and shipping requirements outlined in the project specific sampling plan. The site operations manager shall be responsible to research, identify and follow all applicable U.S. Department of Transportation (DOT) regulations regarding shipment of materials classified as waste.

3.0 General Method

The objective of sample packaging and shipping protocol is to identify standard procedures which will minimize the potential for sample spillage or leakage and maintain field sampling program compliance with U.S. EPA and U.S. DOT regulations.

The extent and nature of sample containerization will be governed by the type of sample, and the most reasonable projection of the sample's hazardous nature and constituents. The EPA regulations (40 CFR Section 261.4(d)) specify that samples of solid waste, water, soil or air, collected for the sole purpose of testing, are exempt from regulation under the Resource Conservation and Recovery Act (RCRA) when all of the following conditions are applicable:

A. Samples are being transported to a laboratory for analysis;
B. Samples are being transported to the collector from the laboratory after analysis;
C. Samples are being stored (1) by the collector prior to shipment for analyses, (2) by the analytical laboratory prior to analyses, (3) by the analytical laboratory after testing but prior to return of sample to the collector or pending the conclusion of a court case.

Qualification for categories A and B above require that sample collectors comply with U.S. DOT and U.S. Postal Service (USPS) regulations or comply with the following items if U.S. DOT and USPS regulations are found not to apply:

The following information must accompany all samples and will be entered on a sample specific basis on chain of custody records:

- sample collector's name, mailing address and telephone number,
- analytical laboratory's name, mailing address and telephone number,
- quantity of sample,
- date of shipment,
- description of sample, and

in addition, all samples must be packaged so that they do not leak, spill or vaporize.

4.0 General Methods

4.1 Place plastic bubble wrap matting over the base and bottom corners of each cooler or shipping container as needed to manifest each sample.

4.2 Obtain a chain of custody record as shown in Figure 1 and enter all the appropriate information as discussed in Section 3.0 of this SOP. Chain of custody records will include complete information for each sample. One or more chain of custody records shall be completed for each cooler or shipping container as needed to manifest each sample.

4.3 Wrap each sample bottle individually and place standing upright on the base of the appropriate cooler, taking care to leave room for some packing material and ice or equivalent. Rubber bands or tape should be used to secure wrapping, completely around each sample bottle.

4.4 Place additional bubble wrap and/or styrofoam pellet packing material throughout the voids between sample containers within each cooler.

4.5 Place ice or cold packs in heavy duty zip-lock type plastic bags, close the bags, and distribute such packages over the top of the samples.

4.6 Add additional bubble wrap/styrofoam pellets or other packing materials to fill the balance of the cooler or container.

4.7 Obtain two pieces of chain of custody tape as shown in Figure 2 and enter the custody tape numbers in the appropriate place on the chain of custody form. Sign and date the chain of custody tape.

4.8 To complete the chain of custody form enter the type of analysis required for each sample, by container, under the "ANALYSES" section. Under the specific analysis enter the quantity/volume of sample collected for each corresponding analysis.

If shipping the samples where travel by air or other public transportation is to be undertaken, sign the chain of custody record thereby relinquishing custody of the samples. Relinquishing custody should only be performed when directly transmitting custody to a receiving party or when transmitting to a shipper for subsequent receipt by the analytical laboratory. Shippers should not be asked to sign chain of custody records.

4.9 Remove the last copy from the chain of custody record and retain with other field notes. Place the original and remaining copies in a zip-lock type plastic bag and place the bag on the top of the contents within the cooler or shipping container.

4.10 Close the top or lid of the cooler or shipping container and with another person rotate/shake the container to verify that the contents are packed so that they do not move. Improve the packaging if needed and reclose.

When transporting samples by automobile to the laboratory, and where periodic changes of ice are required, the cooler should only be temporarily closed so that reopening is simple. In these cases, chain of custody will be maintained by the person transporting the sample and chain of custody tape need not be used. If the cooler is to be left unattended, then chain of custody procedures should be enacted.

4.11 Place the chain of custody tape at two different locations on the cooler or container lid and overlap with transparent packaging tape. For coolers with hinged covers, if the hinges are attached with screws, chain of custody tape should also be used on the hinge side.

4.12 Packaging tape should be placed entirely around the sample shipment containers. A minimum of one to two full wraps of packaging tape will be placed at at least two places on the cooler. Shake the cooler again to verify that the sample containers are well packed.

4.13 If shipment is required, transport the cooler to an overnight express package terminal or arrange for pickup. Obtain copies of all shipment records as provided by the shipper.

4.14 If the samples are to travel as luggage, check with regular baggage.

4.15 Upon receipt of the samples, the analytical laboratory will open the cooler or shipping container and will sign "received by laboratory" on each chain of custody form. The laboratory will verify that the chain of custody tape has not been broken previously and that the chain of custody tape number corresponds with the number on the chain of custody record. The analytical laboratory will then forward the back copy of the chain of custody record to the sample collector to indicate that sample transmittal is complete.

5.0 Documentation

As discussed in Section 4.0 the documentation for supporting the sample packaging and shipping will consist of chain of custody records and shipper's records. In addition a description of sample packaging procedures will be written in the field log book. All documentation will be retained in the project files following project completion.

CHAIN OF CUSTODY RECORD

Client/Project Name	Project Location	ANALYSES
Project No.	Field Logbook No.	
Sampler: (*Signature*)	Chain of Custody Tape No.	

Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample							REMARKS

Relinquished by: (*Signature*)	Date	Time	Received by: (*Signature*)	Date	Time
Relinquished by: (*Signature*)	Date	Time	Received by: (*Signature*)	Date	Time
Relinquished by: (*Signature*)	Date	Time	Received for Laboratory: (*Signature*)	Date	Time
Sample Disposal Method:			Disposed of by: (*Signature*)	Date	Time

SAMPLE COLLECTOR	ANALYTICAL LABORATORY	ERT
ERT - A Resource Engineering Company 696 Virginia Road Concord, MA 01742 617-369-8910		№ 1663

1974-3-84

Figure 1

ERT

Date ______________________________

Sig. ______________________________

№ 30432

Figure 2

ERT

STANDARD OPERATING PROCEDURE

Number: 7600 Date of Issue: 1st Quarter, 1984

Title: Decontamination of Equipment

Organizational Acceptance	Authorization	Date
Originator	[illegible]	3/2/84
Department Manager	[illegible]	3/2/84
Divisional Manager	[illegible]	3-2-84.
Group Quality Assurance Officer	[illegible]	3/2/84
Other		

Revisions	Changes	Authorization	Date
1	Update	SMW	3/2/84
		CSM	3/2/84
		AGC	3/2/84
		EM	3-2-84

1.0 General Applicability

This SOP describes the methods to be used for the decontaminization of all field equipment which becomes potentially contaminated during a sample collection task. The equipment may include split spoons, bailers, trowels, shovels, hand augers, or any other type of equipment used during field activities.

Decontamination is performed as a quality assurance measure and a safety precaution. It prevents cross-contamination between samples and also helps to maintain a clean working environment for the safety of all field personnel involved, including the environment.

Decontamination is mainly achieved by rinsing with liquids which include: soap and/or detergent solutions, tap water, deionized water, and methanol. Equipment will be allowed to air dry after being cleaned or may be wiped dry with chemical free cloths or paper towels if immediate re-use is needed.

The frequency of equipment use, dictates that most decontamination be accomplished at each sampling site between collection points. Waste products produced by the decontamination procedures such as waste liquids, solids, rags, gloves, etc. will be collected and disposed of properly based on the nature of contamination. All cleaning materials and wastes should be stored in a central location so as to maintain control over the quantity of materials used and/or produced throughout the study.

2.0 Responsibilities

It is the primary responsibility of the site operations manager to assure that the proper decontamination procedures are followed and that all waste materials produced by decontamination are properly stored and disposed of.

It is the responsibility of the project safety officer to draft and enforce safety measures which provide the best protection for all persons involved directly with sampling and/or decontamination.

It is the responsibility of any subcontractors (i.e., drilling contractors) to follow the proper, designated decontamination procedures that are stated in their contracts and outlined in the Project Health and Safety Plan.

It is the responsibility of all personnel involved with sample collection or decontamination to maintain a clean working environment and to ensure that any contaminants are not negligently introduced to the environment.

3.0 Supporting Materials

- cleaning liquids: soap and/or detergent solutions, tap water, deionized water, methanol
- personal safety gear (defined in Project Health and Safety Plan)
- chemical-free paper towels
- disposable gloves
- waste storage containers: drums, boxes, plastic bags
- cleaning containers: plastic buckets, galvanized steel pans
- cleaning brushes

4.0 Methods or Protocol for Decontamination

4.1 General Procedures

4.1.1 The extent of known contamination will determine to what extent the equipment needs to be decontaminated. If the extent of contamination cannot be readily determined, cleaning should be done according to the assumption that the equipment is highly contaminated until enough data are available to allow assessment of the actual level of contamination.

4.1.2 Adequate supplies of all materials must be kept on hand. This includes all rinsing liquids and other materials listed in Section 3.0.

4.1.3 The standard procedures listed in the following section can be considered the procedure for full field decontamination. If different or more elaborate procedures are required for a specific project, they will be spelled out in the project work plan. Such variations in decontamination may include following all, just part, or an expanded scope of the decontamination procedure stated herein.

4.2 Standard Procedures

4.2.1 Remove any solid particles from the equipment or material by brushing and then rinsing with available tap water. This initial step is performed to remove gross contamination.

4.2.2 Wash equipment sampler with the soap or detergent solution.

4.2.3 Rinse with tap water

4.2.4 Rinse with deionized water

4.2.5 Rinse with methanol

4.2.6 Repeat entire procedure or any parts of the procedure if necessary

4.2.7 Allow the equipment or material to air dry before re-using

4.2.8 Dispose of any soiled materials in the designated disposal container

5.0 Specific Decontamination Procedures

5.1 Submersible Pump

5.1.1 Applicability

This procedure will be used to decontaminate submersible pumps between ground-water sample collection points and at the end of each day of use.

5.1.2 Materials

- o plastic-nalgene upright cylinder
- o 5-10 gallon plastic water storage containers
- o methanol and dispenser bottle
- o deionized water and dispenser bottle
- o chemical free paper towels

5.1.3.1 During decontamination the submersible pump will be placed on a clean surface or held away from ground.

5.1.3.2 When removing the submersible pump from each well the power cord and discharge line will be wiped dry using chemical-free disposable towels.

5.1.3.3 Clean the upright plastic-nalgene cylinder with first a methanol and then a deionized water rinse, wiping the free liquids after each.

5.1.3.4 Reverse pump backwashing all removable residual water present in the pump tubing. The pump should be shut off as soon as intermittent flow is observed from the reverse discharge.

5.1.3.5 Rinse the stainless steel submersible down hole pump section with a liberal application of methanol and wipe dry.

5.1.3.6 Place the submersible pump section upright in the cylinder and fill the cylinder with tap water, adding 50-100 ml of methanol for every one liter of water.

5.1.3.7 Activate the pump in the forward mode withdrawing water from the cylinder.

5.1.3.8 Continue pumping until the water in the cylinder is pumped down and air is drawn through the pump. At this time air pockets will be observed in the discharge line. Shut off the pump immediately.

5.1.3.9 Remove the pump from the cylinder and place the pump in the reverse mode allowing that all removable water be discharged on to the ground surface as discussed in Step 2.

5.1.3.10 Using the water remaining in the cylinder, rinse the sealed portion of the power chord and discharge tube by pouring the water carefully over the coiled lines.

5.1.3.11 When reaching the next monitoring well place the pump in the well casing and wipe dry both the power and discharge lines with a clean paper towel as the pump is lowered.

5.1.4 Quality Assurance

To assure that decontamination is complete, field blank samples shall be collected using the cleaned submersible pump. These field blanks will be subsequently analyzed for the parameters of interest with respect to the ground water.

The procedure for collecting the field blanks will comprise using the pump to withdraw the tap water used for decontamination, from the plastic cylinder to sample containers. This field blank sample collection procedure shall only be performed after the materials to be used have been decontaminated.